ights Reserved.] Telegraphic Address: "Agreeky, London." ABC Code. [Registered at G.P.O. as a Newspaper.

VOL. XVIII.
NO. CCCCXXVI.] JANUARY 22, 1886. [PRICE FOURPENCE.

FEB 4 18
HARVARD COLLEGE

THE ELECTRICAL REVIEW

LONDON: PUBLISHING OFFICE, 22, PATERNOSTER ROW, E.C.—SUBSCRIPTION per annum, Postage inclusive, in Great Britain, 19s. 6d.; to Countries in Postal Union, of the first class, 21s. 8d.; of the second class (Aden, India, Persia, &c.), 23s. 10d.—NEW YORK: D. VAN NOSTRAND, 23, Murray Street, and 27, Warren Street. Paris: Madame VEUVE J. BOYVEAU, Librairie Etrangère, 22, Rue de la Banque. BERLIN: A. ASHER & Co., 5, Unter den Linden.

JOHNSON & PHILLIPS,
TELEGRAPH ENGINEERS, ELECTRICIANS AND CONTRACTORS.

OFFICES:—14, UNION COURT, OLD BROAD STREET, LONDON, E.C. WORKS:—CHARLTON, KENT.
TELEGRAPHIC ADDRESS:—"JUNO" LONDON.
UNITED EXCHANGE TELEPHONE No. 1,010. PRIVATE WIRE, CITY OFFICES TO WORKS.

Manufacturers of all Telegraph Appliances, Materials, and Machinery for Making Laying and Maintaining Submarine Cables, and Contractors for Underground and Aërial Telegraphs.

Sole Makers of Trott & Hamilton's Patent Grapnel Rope and Trott & Kingsford's Patent Indicating Grapnels.

Iron and Steel Telegraph Buoys, Grapnels, both Patent and Ordinary; Centipedes, Creepers, Mushrooms, Sinkers, Cable Tanks, Picking-up and Paying-out Machinery, Dynamometers, Bow and Stern Gear, Steam and Hand Hauling Gears, Rope and Chain Fittings, Cable Drums, Splicing and Jointing Tools, &c., &c.

Machinery Designed and Constructed for the Complete Equipment of Telegraph Cable Factories and Vessels. Steam and Hand Wire Sounding Machines for Deep and Shallow Water.

All Apparatus and Material used in the Construction, Maintenance, and Working of LAND LINES, viz.:—
POLES—Wrought Iron or Composite Poles for Telegraph, Telephone, and Electric Light purposes. House-Top Poles and Fittings.
INSULATORS—*Johnson & Phillips'* Patent Fluid Insulators, and all kinds of the ordinary form, Shackles, Shackle Straps, &c.
WIRE—Iron and Steel Wire, Galvanised, Plain, or Stranded. Insulated Wires of every description.
BATTERIES—Sole Makers of *Higgins'* Patent Bichromate Batteries, Leclanché, &c. Zinc and Carbon Plates.
INSTRUMENTS.—Morse, Needle, Bells, Galvanometers, and other Testing Instruments.

Makers of Underground, Aërial, Torpedo, and Field Cables, with Single or Multiple Cores.

Insulated Copper Wires in Vulcanized India-rubber, G.P., Silk and Cotton; taped or braided.
Lightning Conductors of the most approved types.

Makers of Dynamos, Lamps, Cables, Carbons, Switches, &c., &c. { ELECTRIC LIGHTING. } Stock of Carbons, &c., kept ready for immediate delivery.

SOLE MAKERS OF THE
BROCKIE-PELL PATENT "UNIVERSAL"
ARC LAMP,
WHICH IS
ABSOLUTELY STEADY,
And can be used on the same circuit with other lamps.

No clockwork, springs, liquid dash-pots, nor make-and-break contacts to get out of order.

FULL PARTICULARS FURNISHED ON APPLICATION

SOLE MAKERS OF THE
BROCKIE-PELL PATENT "UNIVERSAL"
ARC LAMP,
WHICH IS
ABSOLUTELY STEADY,
And burns 18 hours with one pair of carbons.

The only Arc Lamp that can be used with comfort to the eyes for interior lighting.

Of any Power from 500 Candles upwards.

PATENT ROLLED
SHAFTING
IN IRON AND STEEL.

By Royal Letters Patent.

The Kirkstall Forge
Company, Leeds,
SOLE MAKERS.

BUTLER'S PATENT FRICTIONAL COUPLINGS.

SILVER MEDAL, INTERNATIONAL ELECTRIC EXHIBITION, 1882.
International Inventions Exhibition, 1885, GOLD MEDAL for Machinery, SILVER MEDAL for Cables and Wire.

MANUFACTURERS
(*By Patent Processes*)
OF
Silk and Cotton Covered Wire and Tape of all Sizes for Electrical purposes.

Specially Insulated Electric Light Leads, Cables and Multiple Wire for the various Systems.

MANUFACTURERS
(*By Patent Processes*)
OF
Fancy Silk Covered and Flexible Wires for Lamp Suspending, &c.

Double Concentric Electric Light Cables for Ship Work.

All classes of Aërial and Underground Cables to any Specification.

Special Anti-Induction Cables for the Telephone.

Contractors to H.M. Postmaster-General, the Indian Government, the principal Railway, Telephone, and Electric Light Companies.

MANUFACTURERS, BY PATENT PROCESSES, OF
GLOVER'S PATENT COVERED IRON WIRE FOR AËRIAL LINES.
Glover's Patent Covered High-Conductivity Copper Wire for Aërial Lines.
GLOVER'S PATENT COVERED GUTTA PERCHA WIRE
FOR LEADING-IN, TUNNEL, AND UNDERGROUND WORK.
Thoroughly Insulated Anti-Induction Telephone Cables up to ONE HUNDRED Wires.

WALTER T. GLOVER & CO.,
Electrical Wire and Cable Makers,
TELEGRAM ADDRESS: "WALTER GLOVER," SALFORD. | SALFORD, MANCHESTER. | ESTABLISHED 1868.

WORKS:—
Bridgewater Street Iron Works.
Salford Electric Wire Works.
Springfield Lane Cable Works.
SALFORD.

ELECTRICAL POWER STORAGE COMPANY, LIMITED,
Offices:—4, GREAT WINCHESTER ST., E.C. Works:—MILLWALL, E.
Telephone Nos.—Office, 238; Works, 5,116. Registered Telegraphic Address—"STORAGE," LONDON.

SOLE MANUFACTURERS OF
THE "E.P.S." ACCUMULATORS
(Faure, Sellon, Swan, Volckmar and other Patents)
FOR ELECTRIC LIGHTING ON INCANDESCENT OR ARC SYSTEM, OR FOR MOTIVE POWER.
The only GOLD MEDAL awarded for improvements in ACCUMULATORS at the International Inventions Exhibition was given to this Company.

Manufacturers of Electrical Tramcars, Launches and Hoists; Motors and Propelling Gear; also Main Distributing Switch Boards, Fittings and Automatic Switches for Installations.

CONTRACTORS for the COMPLETE INSTALLATION of the ELECTRIC LIGHT in PRIVATE HOUSES
ELECTRIC LIGHTING FOR BALLS, DINNER PARTIES, &c.

NOTICE IS HEREBY GIVEN that every manufacturer and individual user of any secondary battery of the construction or form covered by the above Company's patents *without a license* renders himself responsible for such unlawful manufacture and use, and all the consequences thereof. The only firm of manufacturers, in Great Britain, so licensed are Elwell-Parker, Limited, for lighting purposes only.

THE TELEGRAPHIC JOURNAL AND
Electrical Review.
VOL. XVIII.—NO. 426.

THE TRAMWAY TRACTION OF THE FUTURE.

ONE of the most important papers bearing upon the practical applications of electricity which has ever been compiled is that which Captain Douglas Galton, F.R.S., read before the meeting of the Society of Arts on Wednesday evening last. To the advocates of electrical propulsion for tramcars, and we must include ourselves amongst its warmest supporters, the facts contained therein must be welcome indeed, and the author's name is a sufficient guarantee of their veracity, for Captain Galton is not the kind of man to be led astray by enthusiasm over a novelty or by a partiality to any particular means of arriving at an end. For several years past experiments, duly recorded in the REVIEW, have been made intermittently in different directions with tramcars for which the motive power has been electrical energy, applied in a variety of ways. Three or more tram lines have now indeed their cars regularly run by electrical means. Two of these, however, are happily placed in localities where water-power is plentiful and readily available, and we have therefore but meagre information respecting the details of working such lines in large towns where it would be necessary to employ steam engines, dynamos, and accumulators, and erect charging stations. On the whole, then, it could scarcely be expected that much enterprise would be forthcoming towards supporting an undertaking which should revolutionise our present methods of locomotion and of which so little was definitely known. In America and on the Continent things are ordered differently; new ideas are made to rapidly develop, they are then commercially treated and the results soon spread abroad. If successful, we begin to think that it is time we took advantage of the outcome of foreign capital and enterprise, and we slowly commence to imitate that which we could and ought in nine cases out of ten to initiate.

We will not, however, moralise upon that which is apparently inherent in the British character, and therefore presumably unalterable, but return to the paper upon which we base our remarks.

Our readers are doubtless aware that an interesting feature in the late International Exhibition at Antwerp was the competition between different forms of mechanical motors on tramways for use in towns.

In this country the development of tramway lines has been very great, and in populous districts these supply a want which light railways, even if constructed, could never properly fill. Tramways, to satisfactorily fulfil their functions, must be operated by mechanical traction, and the motor which is found most adaptable will eventually come to the fore.

The competitions between different forms of motors at the Antwerp Exhibition was carefully superintended, and their qualities and defects ascertained; this at least affords a starting point from which it will be possible to carry on further investigations.

The experiments were made on a specially constructed line ending in a triangle of 505 metres, thus enabling those motors which did not reverse to run in the same direction. Of the total length, viz., 2,797 metres, 2,295 metres were in a straight line, 189 metres in curves of $1\frac{3}{4}$ chains radius, and 313 metres in curves of 1 chain radius. There were four passing places, exclusive of the terminus, and these were joined to the main line by curves having a radius of $1\frac{3}{4}$ chains. The track was practically level, the locality affording no opportunity for obtaining a line with steep gradients.

The experiments lasted four months, and there were five competitors. Of these, three systems were based on the direct action of steam:—the Krauss locomotive, separate from the carriage; the Wilkinson locomotive, also separate; and the Rowan engine and carriage combined. The fourth was the Beaumont compressed-air engine; and the last, but as will be seen not least, a single electrical car.

It is not our intention to describe the four first-mentioned methods, but the details of the electrically propelled car may be found in our other columns.

A regular service was established according to a fixed time table, to which each motor was required to conform. Each journey was reckoned as starting from the end near the Exhibition proceeding to the beginning of the triangle and returning to the starting point. An hour was allowed between the commencement of each journey, 14 minutes were allowed for a stoppage at the end near the Exhibition, and 18 minutes at the other end—thus allowing 28 minutes for travelling 2 miles 1,500 yards, a speed of about 6 miles an hour. The motors were required to work four days out of six, and on one of the four days to draw a supplementary carriage.

An official, assisted by a storekeeper, was appointed to keep a detailed record:—

1. Of the work done by each of the motors.
2. Of any delays occurring on the journey, and of the cause.
3. Of the consumption of fuel, both for lighting the fires and for working.
4. Of the consumption of grease.
5. Of the consumption of water.
6. Of all repairs of whatever nature.
7. Of the frequency of cleaning and other necessary operations required for the efficient service of the motor.

From the foregoing, and from the further details given on other pages, it will be seen that the tests were of a very prolonged, definite, and exhaustive nature, and the result speaks volumes for the electrical system, notwithstanding the car gearing, which cannot meet with approval. Although Captain Galton's conclusions are generally in favour of electrical propulsion, he is careful to point out several matters on which he thinks we have not yet obtained sufficiently reliable data.

It is not a little curious that while in the body of his paper he speaks of the accumulators as having the prospect of lasting indefinitely, he should be so dubious as to their durability in his concluding remarks. There is without doubt some degree of uncertainty respecting the "life" of a secondary battery; but if, as we believe, they can be depended upon in electric lighting for a matter of two years, we think they could readily be constructed to remain in workable condition for at least half this period, which would be, commercially speaking and from an economical point of view, long enough for tramcar purposes.

The economy of the system, favourable as it appears even now, might readily be improved. A more efficient charging dynamo could easily be obtained, and the steam engine used, as Captain Galton implies, might easily have been a better one.

Apropos of this dynamo, we are told it delivers a current of 20 ampères at 90 volts; that the process of charging the accumulators occupied 12 hours with a current of 13 ampères, and that the intensity varied between 25 and 23·5 ampères during the whole time of charging. These statements are somewhat confusing and require explanation.

That an absolutely reliable self-contained electrical car can be produced, indeed has been produced and is waiting to be utilised, we have no hesitation in saying, and we think that a great impetus will be given to this branch of applied electricity by the publication, just when most needed, of Captain Galton's able and comprehensive paper.

The managers of both the Portrush-Giant's Causeway and the Bessbrook-Newry lines, Mr. Holroyd Smith with his Blackpool venture, and Mr. Magnus Volk, with further information respecting his very successful Brighton line, would do good service by relating their latest experiences in electrical tramway work. Mr. Reckenzaun's personal narrative of his Berlin triumphs would be most welcome, and may be Mr. Elieson has some further progress to relate. Such a supplement to Captain Galton's work would be eagerly welcomed by the electrical world generally.

THE METERS OF PROFESSORS AYRTON AND PERRY.

EVERYONE who has anything to do with the running of arc or incandescent lamps, says Mr. Geo. B. Prescott, Jun., in the New York *Electrician*, realises the necessity of using some sort of current and potential indicators or measurers to insure uniform and satisfactory working. The portability and simplicity of Profs. Ayrton and Perry's voltmeters and ammeters have recommended them to practical men, and they are now extensively employed in commercial electric lighting. Although it is more or less well known that the moment of the permanent magnets in these instruments is subject to change, and that the value of their constants is thereby altered, but few of the actual users are aware of the extent of this variation. Even less known is the fact that the heating of the coils, particularly in the voltmeters, is another serious source of error, whilst the circumstance that in these meters a division of the scale near the zero end represents a much greater variation, in potential or current as the case may be, than a division near the other end, is almost entirely overlooked. It is evident that an instrument containing so many defects must be handled with judgment to obtain even approximately correct results, and to supply the necessary information on which to base such judgment is the object of this article. I should not consider it needful, however, if there was a more reliable and equally cheap and convenient substitute for these instruments on the market.

The results of careful tests of a large number of Ayrton and Perry's voltmeters and ammeters, extending over a period of nearly three years, may be summed up as follows:—

The permanent magnets gradually grow weaker, reducing the value of the constant.

The change is more rapid in new instruments than in old ones.

The change is more rapid in instruments which are used frequently than in those seldom used.

The change is modified by stronger magnets, such as dynamos.

The percentage change in the value of the constant is different in several instruments under apparently the same conditions.

The error due to heating of the coils is very noticeable in the ammeters, and seriously affects the voltmeters, increasing the value of the constant in both cases.

The difference in the value of a scale division at 0° and at 45° varies from 10 to 20 per cent. in different instruments.

For the same instrument a change in the strength of the permanent magnet does not alter the above percentage.

The information supplied by these facts leads to the conclusion that to obtain satisfactory results from these instruments the following conditions should be observed:—

Their constants should be frequently determined.

They should be calibrated at the current strength and potential at which they are to be used.

The voltmeter readings should be taken immediately after the needle comes to rest, and the circuit then broken. The readings should not be taken so frequently as to heat the coils.

Experience has shown that with wire of the size commonly used, the resistance of the voltmeters should not be less than 50 ohms for each volt to be measured. The wire in the ammeters should be sufficiently large to carry without appreciable heating at least double the current to be measured. They should be calibrated as often as once a fortnight to once in three months, according as they are new and much used or old and little used.

Selected according to the above specifications, and used with the precautions suggested, these ammeters and voltmeters may be made to yield results sufficiently reliable for most commercial work.

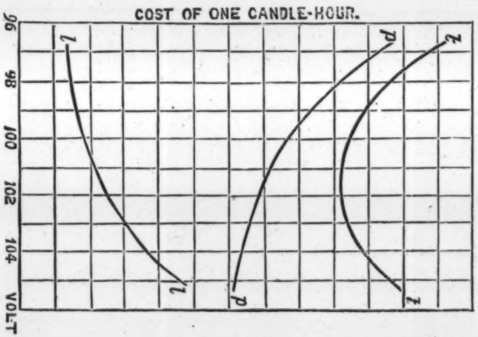
COMMERCIAL EFFICIENCY OF INCANDESCENT LAMPS.

MANY makers of incandescent lamps have found that their lamps, upon being measured, have given a much better efficiency (that is, much more light per horse-power) than other lamps in the market, and have used this as an advertisement of their lamp. For a long time, writes Mr. Carl Hering in the New York *Electrician*, and by many makers, this seems to have been the sole object, that is, to get as much light as possible from a given horse-power. In the tests made by the Board of Examiners at the exhibitions at Paris, Munich and Vienna, and by the first Board of Examiners at the Philadelphia Exhibition, this was the only and principal measurement deemed necessary to make of incandescent lamps, and the public was left to judge from the figures obtained what the relative values of the different systems were.

In the Vienna tests, the lamps were measured with different currents, and the corresponding efficiency calculated. These values showed that the efficiency increased very fast with an increased current; in some cases even the candle-power increased with the cube of the electrical energy in the lamp. The very high efficiency of less than one watt per candle was obtained in several cases, and tended to show that these lamps were the best. In another case a lamp whose normal candle-power was only about 40 was run as high as 600 candles.

It is evident, however, to any one who has experimented intelligently with incandescent lamps, that there is another factor to be considered, namely, the life of the lamp, which, as we shall see below, sometimes has as much, and even more weight in the real commercial efficiency than the watts per candle-power. It is a well-known fact that the greater the current the better the efficiency as regards power alone, but at the same time the shorter the life of the lamps; so that many of the lamps which show such a good efficiency are really poorer lamps than those which give a less efficiency, showing that a test of efficiency by itself is of little or no value; in fact, often misleading, doing injustice to the very lamps which are really the best when the real commercial efficiency is considered, in which, of course, the life of the lamp and its cost are also main factors.

As the cost per candle-power decreases very much with an increased current, and as the life of a lamp decreases with an increased current, or what is the same thing, the cost for lamps increases with an increased current, it is evident that there is some one current or voltage at which the total cost, considering both lamps and power, is a minimum. This may be shown graphically very nicely by the adjoining diagram, taken from an excellent article on the subject by Profs. Ayrton and Perry. The abscissæ represent the potential at which the lamps were run, and the ordinates represent the cost.



The curve, *l*, *l*, represents the cost of the lamps themselves, if they are run at different potentials, or what amounts to the same thing, with different currents. This is, of course, dependent upon the life which the lamp has at those different potentials, and the cost of a single lamp. It shows that this cost increases more rapidly as the potential, and therefore the current, increases. The curve, *p*, *p*, represents the cost of the power required per candle when run at different potentials or current, and shows that it decreases rapidly at first, and less so for greater potentials. As the decrease toward the end of the latter is not as much as the increase in the first curve, it is evident that the sum of the two will fall at first, and rise again towards the end, showing that at a certain point there will be a minimum cost. This is shown by the third curve, *t*, *t*, which represents the total cost or the sum of the two others. As will be seen this becomes a minimum at a certain point, which for the particular lamp from which the data was taken, is about 102 volts, or thereabout. This, as is seen, is determined theoretically to a certain extent, while, if the writer is correct in the particular make of lamp which he assumes was used, the manufacturer found about the same result in a purely practical way by running the lamps at different potentials and finding their life, from which they determined the proper potential at which they should run their lamps.

From what was said above it is very evident that in order to determine the real relative values of different lamps to the consumer, their life and the cost of a lamp must be taken into consideration besides the efficiency. The real values of different systems of lamps to the consumer also depends greatly on the way in which the lamps and installations are made, that is whether the lamps are liable to fail at the connection between the platinum wires and the filament; what the durability of the filament is, as regards mechanical strength; the nature of the holder, that is whether the contacts between the lamp and holder are good, firm and not liable to heat; also the price and nature of holder, &c., &c. But it is evident that such factors cannot possibly be brought into any general calculation or formula, and will have to be left to the buyer to judge upon, or to an electrical engineer who is consulted.

To reduce the first mentioned qualities to a form in which different lamps may be compared, the following formula may readily be deduced :—

Let C represent the cost in cents, of one spherical candle-power per hour.
e the efficiency in watts per spherical candle-power, of the lamp at its normal candle-power.
P the price, in cents, of one electrical horse-power per hour in the lamp.
p the price of a lamp in cents.
L the life in hours, of a lamp at its normal candle-power.
c the normal spherical candle-power of a lamp.

Then the cost of one candle-power hour, as far as the efficiency is concerned, is the horse-power consumed multiplied by the price of one horse-power, that is,

$$\text{C} = \frac{e}{746}\,\text{P}.$$

The cost of one candle-power hour, as far as life is concerned, is the price of a lamp divided by the candle-power hours which the lamp is capable of giving, which latter is evidently the life multiplied by its spherical candle-power. This gives

$$\text{C} = \frac{p}{\text{L} \times c}.$$

The total cost in cents, of one spherical candle-power is, therefore, the sum of these two expressions, that is

$$\text{C} = \frac{e\,\text{P}}{746} + \frac{p}{\text{L} \times c}.$$

The only reliable data which can be used justly in making any relative comparisons of different lamps by means of this formula are the results of the excellent and thorough tests made by a special committee under the auspices of the Franklin Institute in the spring of 1885. They are the only impartial tests made of incandescent lamps of different systems which give the life and efficiency of different lamps at their normal candle-power. It is very unfortunate that one of the principal electric light companies in this country, had such a misfortune in regard to the lamps delivered to the test committee. It is very much to be regretted, as the tests of this lamp were looked upon with special interest. The results of this lamp, the Weston, in the following comparisons, cannot therefore be justly compared with the others. If, however, this company guarantees a certain life at the same efficiency obtained in the test, the comparison can be justly made with the others.

From the report of these tests, we find the average efficiency of the lamps of each of the different systems in watts per spherical candle-power to be as follows :—

Edison	4·459
Stanley 96 volts	4·04
Stanley 44 volts	3·544
Woodhouse & Rawson, 1st lot ...	3·605
Woodhouse & Rawson, 2nd lot ...	3·56
White	4·05
Weston 110½ volts	3·713
Weston 70 volts	4·51

In order to obtain the real average life of all the lamps used, it would have been necessary to run them all until they died, but as this was not done it will be impossible for us to get the real life from the tests. In order, therefore, to make any relative comparisons from them, it is necessary to make some assumptions in regard to the death of the surviving lamps. Although such assumptions may not be quite correct they will be at least approximately so, and will enable us to make a comparison which will, at least, give tolerably fair results.

As most of the lamps which survived have a discoloration of at least two and one-half, and many of them three to four, in a scale of six, it will not be far wrong to assume that those lamps died at the end of the test. This is a wrong assumption, but we have no right to assume a certain life for these lamps, as that would be different for different systems, nor have we a right to take only those lamps which died before the end of the test. This assumption will, however, give results which are within the limit which would be obtained if we knew the real life, that is, the real ultimate cost will not be more than the results obtained.

It will furthermore be seen from the test that the candle-power decreases very materially in most lamps, and by taking the efficiency at the beginning of the test, the error may be left to compensate, to a certain extent, the incorrect assumption that they died at the end of the test. At all events it will not be giving any lamp any undue credit to make the first assumption, and if with the final results it is remembered that a certain number survived and would have increased the life accordingly, and therefore decreased the ultimate cost slightly, it will enable one to make at least a rough comparison of the different systems. Although the results obtained thus give only rough values, it is easily seen that unless some such assumption were made, no relative results could be obtained from the tests.

Making this assumption, the average life of each of the different systems of lamps are as follows :—

Edison	1,026 hours.
Stanley 96 volts	430 „
Stanley 44 volts	293 „
Woodhouse & Rawson, 1st lot ...	290 „
Woodhouse & Rawson, 2nd lot ...	267 „
White	273 „
Weston 110½ volts	507 „
Weston 70 volts	461 „

Another assumption can be made, which may be nearer the real result, though at the same time it may give undue credit to some of the systems. At the end of the test the lamps were examined in regard to their discolouration and marked with a scale of six units, of which number six was quite dark, totally unfitting the lamp for use if it was burning. To assume, therefore, that a lamp with a discolouration of five was practically dead will not be very incorrect. It is also quite fair to suppose that the discolouration increases directly as the number of hours which the lamp burns. From this it can readily be calculated from the data of the tests at what age the survived lamps would have had a discolouration of five on the adopted scale of six units, and to consider the lamp practically dead then.

Making this assumption and calculation the average life of all the lamps of each system gives :—

Edison	2,038 hours.
Stanley 96 volts	501 „
Stanley 44 volts	319 „
Woodhouse & Rawson, 2nd lot...	305 „
White	407 „
Weston 110½ volts	1,022 „
Weston 70 volts	1,012 „

The price of a lamp to a consumer of a 100-light plant, given to the writer by the different companies, is as follows :—

Edison	85 cents.
Stanley 96 volts	70 to 75 „
Stanley 44 volts	70 to 75 „
Woodhouse & Rawson... ...	120 „
White	100 „
Weston 110½ volts	85 „
Weston 70 volts	85 „

The Stanley Company not having been heard from, the price of that lamp was taken as given by the Van Depoele Company, who use that lamp. They gave the price for a 100 volt lamp ; the writer assumed the same price for the 44 volt lamp. As the writer could not find out the cost of the Woodhouse & Rawson lamp, the price assumed was that at which the lamps were offered in large quantities to the writer, in London, about a year ago, namely, five shillings, their great efficiency being offered by the makers as an explanation for their high price.

Assume the cost of a mechanical horse-power per hour as applied to the pulley of a dynamo, including coal, attendance, shafting, &c., to be four cents, and that the commercial efficiency of the dynamo (that is, the ratio of the electrical power in the external circuit to the mechanical power applied at the belt) is 88 per cent., and that five per cent. is lost in the leads. This makes the cost in cents of an electrical horse-power in the lamp,

$$P = \frac{4}{\cdot 88 \times \cdot 95} = 4\cdot 8 \text{ cents.}$$

Introducing all these values together with those given above into our equations, calculating the cost of the power from the efficiency in watts per candle-power, and the cost due to the life from each of the above assumptions, gives the results in the following table.

Column i. is the cost of a lamp as given by the respective companies, with the above-mentioned exception. Columns ii. and iii. are taken directly from the report. Column iv., calculated with our formula, is dependent only on the efficiencies in column iii., and on the cost of a horse-power. Columns v. and x. are calculated from the results of the tests assuming that the survived lamp died as above explained. Columns vi. and xi. are calculated with our formula from columns v. and x., each combined with columns i. and ii. Columns vii. and xii. are the sums of column iv. with columns vi. and xi. respectively, and are the ultimate results which interest the consumer. Columns viii., ix., xiii. and xiv. are of interest to the manufacturer, showing how much of the total cost is due to the efficiency, that is, the power, and how much is due to the life and the cost of the lamp. Column xv. is the relative commercial rank of the different lamps as obtained from the results in column xii. It will be noticed that this is the same in the case of the Weston lamp whether the life, as given by the test, is taken, or whether the guaranteed life of 1,000 hours is taken.

As mentioned above, the Weston lamps used in the tests were unfortunately from a poor lot, and are not as good as their average lamps ; they were therefore pronounced useless by that company. The writer was informed by that company that they guaranteed their lamps to have a life of from 600 to 1,000 hours, depending on the nature of the installation, that is, whether the engine runs steadily, &c. The last two lines in the table were therefore calculated with this assumed life, and give the figures which can be justly compared with the rest. It will be noticed, however, that no matter whether the figures in column vii. or xii. are taken, or whether the life, as given by the test or as guaranteed, are taken, the Weston high tension lamp is still the most economical, with the assumed cost of a horse-power hour four cents. If the price is more than that, which it will be in many installations, the results will be still more in favour of the good efficiency lamps (see column iii.).

The way the results will be affected by a different cost of the power than that assumed, will easily be seen from the table. A higher cost of a mechanical horse-power hour than four cents. will decrease the relative ultimate costs for the high efficiency lamps, such as the Stanley 44 volt, the Woodhouse & Rawson and the Weston 110½ volt; while it will increase the relative ultimate costs for the poor efficiency lamps such as the others.

It will also be noticed from the table, columns viii., ix., xiii., xiv., that those lamps in which the cost for the power is a large proportion of the total cost, the life and cost of a lamp play but a small part in the whole cost, and that increasing the life will be of comparatively little value. But if in these lamps the efficiency be increased at the expense of the life, it will be a decided advantage. From the figures for the Edison lamps it will be seen that increasing the life from about 1,000 hours to 2,000 hours decreases the ultimate cost only about eight per cent.

Name of lamp.	Cost, in cents, of a single lamp.	Mean spherical candle-power at beginning of test.	Efficiency in watts per spherical candle-power.	Cost, in cents, of power for 1 spherical candle-power hour.	Assuming survived lamps to have died at end of test.					Assuming survived lamps to have died when their discolouration would have been 5.					Relative commercial rank of lamps from column xii.
					* Average life in hours.	Cost, in cents, of lamp for 1 spher. C.P. hour.	Total cost, in cents, for 1 spher. C.P. hour.	Per cent. of cost for power.	Per cent. of cost for lamp.	Average life in hours.	Cost, in cents, of lamp for 1 spher. C.P. hour.	Total cost, in cents, for 1 spher. C.P. hour.	Per cent. of cost for power.	Per cent. of cost for lamp.	
No. of Columns.	i.	ii.	iii.	iv.	v.	vi.	vii.	viii.	ix.	x.	xi.	xii.	xiii.	xiv.	xv.
Edison	85	15·47	4·459	·0287	1026	·0054	·0341	84	16	2038	·0026	·0313	92	8	2
Stanley 96 volt	70	13·59	4·04	·0260	430	·0120	·0380	68	32	501	·0103	·0363	72	28	4
Stanley 44 volt	70	13·42	3·544	·0228	293	·0177	·0405	56	44	319	·0163	·0391	58	42	5
Woodhouse & Rawson, 1st lot	120	15·64	3·605	·0232	290	·0264	·0496	47	53	...	...	...	...	...	...
Woodhouse & Rawson, 2nd lot	120	18·30	3·56	·0229	267	·0246	·0475	48	52	305	·0215	·0444	52	48	6
White	100	12·44	4·05	·0261	273	·0294	·0555	47	53	407	·0197	·0458	57	43	7
Weston 110½ volt	85	16·43	3·713	·0238	507	·0102	·0340	70	30	1022	·0051	·0289	82	18	1
Weston 70 volt	85	15·18	4·51	·0290	461	·0121	·0411	71	29	1012	·0055	·0345	84	16	3
Weston 110½ volt	85	16·43	3·713	·0238	600*	·0086	·0324	73	27	1000*	·0052	·0290	82	18	(1)
Weston 70 volt	85	15·18	4·51	·0290	600*	·0093	·0383	76	24	1000*	·0056	·0346	84	16	(3)

* Guaranteed life.

Of the two assumptions made to determine the average life of the lamps, column v. gives undoubtedly too low results, while in column x. they are probably slightly too high, as many of the dead lamps have a discolouration of less than five on the scale, and it is probable that the survived lamps would not have lived until their discolouration was five. The real values of the ultimate cost will, therefore, no doubt be lower than the figures in column vii. and higher than those in column xii. But by comparing these last two columns it will be seen that the relative values for the different lamps are not changed very much, in fact, leaving out the low voltage lamps (Weston 70 volt and Stanley 44 volt), which the writer believes are seldom used, the relative rank remains the same whether the results in column vii. or xii. are taken. Therefore, although the necessary assumptions made to determine the life of the survived lamps, are from their nature not absolutely correct, they show that for two extreme cases the relative values are not changed, and therefore the real relative values which lie between the extremes will be the same.

The writer wishes furthermore to call attention to the fact, that in the above calculations and comparisons there is no "personal" factor, the results being obtained from figures only, and can be calculated by any one from the results of the tests of the Franklin Institute.

A PALACE OF DELIGHT.

SOME few weeks ago a paragraph appeared in these columns announcing that a memorial was to be erected to the late Sir Titus Salt, Bart., which was to take the form of new science and art schools, to be added to the Salt Schools at Saltaire. It was further intimated that the opening of the schools was to be inaugurated by "A Palace of Delight." What this Palace of Delight was to be was then only slightly foreshadowed. The project has since undergone rapid and extensive development. Its limits have now been defined while at the same time the securing of the exhibits and the general arrangements of the exhibition are in a forward state. It has been decided that new schools will be erected on a site adjoining the existing institute, the cost of the new department being estimated at between £8,000 and £10,000. The main feature of the "Palace of Delight" is the fact that it will assume the form of a gigantic garden, eight acres of ground having been appropriated for the purpose. The garden will be surrounded on all four sides by a covered shed similar to that used at the Inventions Exhibition, and on the front side the new schools will stand. In these annexes 62,000 square feet of space is afforded, while the present institute and the new schools contain together about 41,500 square feet of floor, so that altogether 103,500 square feet of floor space will be available for the purposes of the exhibition.

The garden will have an average width of about 450 feet, and a length of over 600 feet. In the centre of the whole will be an illuminated fountain, similar to that seen at the Inventions Exhibition, the basin of which will be 90 feet square. On the south side of the garden facing this fountian will be a covered grand stand, from which a fine view of the playing water will be obtained. The lack of such accommodation was noticed by many visitors to the Inventories. Among the other many special features of the exhibition is an enormous circular tent, which is to be put up at the north-east corner of the garden. This will be one of the largest tents ever erected in England. In other parts of the garden the electric railway and a telpher line will be shown at work. Messrs. Woodhouse & Rawson have undertaken the lighting by electricity of the grounds, the sheds, and the picture galleries; and we observe that Messrs. Marshall, Sons & Co., Limited, of Gainsborough, have offered to build and lend three specially-constructed engines of 100 horse-power each, fitted with Hartnell's patent expansion gear, to work the dynamos. The Postmaster-General will consign for exhibition a complete set of telegraphic apparatus from the earliest time. It is expected that the exhibition will have a postal and telegraph office for its own work. Rapid progress is being made in the new building; operations proceed before sunrise and after sunset by the electric light.

EXPERIMENTS WITH TRAMWAY MOTORS.

IN our leading columns we have, as briefly as the subject will allow, touched upon the paper read by Captain Douglas Galton, F.R.S., on Wednesday evening, before the Society of Arts, and entitled: "Results of Experiments on Mechanical Motors for Tramways made by the Jury on Railway Appliances at the Antwerp Exhibition." The complete paper can be studied in the journal of the Society, our purpose being served by reproducing that portion directly connected with our province. We therefore commence with a detailed description of the electrically propelled car to which Captain Galton thus alludes:—

In the electric tramcar the haulage was effected by means of accumulators. The car was of the ordinary type with two platforms. It was said to have been running as an ordinary tramcar since 1876. It had been altered in 1884 by raising the body about six inches, so as to lift it clear of the wheels, in order to allow the space under the seats to be available for receiving the accumulators, which consisted of Faure batteries of a modified construction. The accumulators employed were of an improved kind, devised by M. Julien, the under manager of the Electric Company, which undertook the work.

The principal modification consists in the substitution, for the lead core of the plates, of one composed of a new unalterable metal. By this change the resistance is considerably diminished, the electromotive force rises to 2·40 volts, the return is greater, the output more constant, and the weight is considerably reduced. The plates being no longer subject to deformation, have the prospect of lasting indefinitely. The accumulators used were constructed in August, 1884.

The car, as altered, had been running as an electric tramcar on the Brussels tramways since October, 1884, till it was transferred to the experimental tramway at Antwerp. The accumulators had been in use upon the car during the whole of this period, and they were in good order at the end of the experiments, that is to say, when the exhibition closed at the end of October, 1885.

There were 36 of these accumulators enclosed in ebonite boxes, each weighing 44 lbs., the total weight being 1,760 lbs. (? 1,584 lbs. —EDS. ELEC. REV.). They were charged in a shed with a Gramme machine of the ordinary kind, giving a current of 20 ampères and 90 volts, driven by a portable engine.

The process of charging occupied 12 hours with a current of 13 ampères (? 23.—EDS. ELEC. REV.); and when complete, the batteries were able to work for 15 hours, and drive the car 46 miles, not counting the stoppages.

The accumulators actuated a Siemens dynamo such as is used for lighting, having a normal speed of 1,000 revolutions, fixed on the frame of the carriage. The motion was conveyed from the pulley on the dynamo by means of a belt passing round a shaft fixed on movable bearings to regulate its tension, and thence to the axles by means of a flat chain of phosphor bronze. The chain was adopted as the means of moving the axle, on account of its simplicity, and facility of repair by unskilled labour.

The speed was fixed at 4 metres per second (which corresponds with a speed of nearly 9 miles per hour), for 1,000 revolutions of the dynamo; and it was regulated by cutting a certain number of the accumulators out of circuit, instead of by the device of inserting resistances which cause a waste of energy. By breaking the circuit entirely the motive power ceased, and the vehicle might either be stopped by the brakes or allowed to run forward by gravity, if the road were sufficiently inclined. The reversal of the motor was effected by means of a lever which reversed the position of the brushes of the dynamo.

The dynamo could be set in motion, and the carriage worked from either end, as desired. The handle to effect this was movable, and as there was only one handle, and this one was in charge of the conductor, he used it at either end as required.

The weight of the tramcar was 5,654 lbs.; the weight of the accumulators was 2,460 lbs. (? see above.—EDS. ELEC. REV.); the weight of the machinery, including dynamo, 1,232 lbs. The car contained room for 14 persons inside and 20 outside. Under the conditions of the competition the car was required to draw a second car occasionally.

The jury made special observations upon the work required to move the car between the 20th September and 15th October, 1885. Seals were attached to the accumulators. Moreover, from the 27th of September, after each charge, seals were placed on the belts from the steam engine to prevent any movement of the Gramme machine, so that there could be no charges put into the accumulators beyond those measured by the jury.

The instruments used for measuring were Ayrton's ampèremeter and Deprez's voltmeter, which had been tested in the Exhibition by the Commission for Experiments on Electrical Instruments, under the presidency of Prof. Rousseau. Besides these, Siemens electro-dynamometer and Ayrton's voltmeter were used to check the results; but there was no practical difference discovered. During the period of charging the accumulators, the intensity of the current and the electromotive force was measured every quarter of an hour, and thence the energy stored up in the battery was deduced. It may be mentioned that the charge in the accumulators, when the experiments were commenced, was equal in amount to that at their termination.

An experiment was made on 21st October to ascertain, as a practical question, what was the work absorbed by the Gramme machine in charging the accumulators. The work transmitted from the steam engine was measured every quarter of an hour by a Siemens dynamometer, at the same time the intensity of the electromotive force given out by the machine, as well as the number of the revolutions it was making, was noted. It resulted that for a mean development of 4 mechanical horse-power, the dynamometer (? dynamo.—EDS. ELEC. REV.) gave into the accumulators to be stored up 2·28 electrical horse-power, or 57 per cent. The intensity varied between 25·03 and 23·51 ampères during the whole time of charging. Of this amount stored up in the accumulators a further loss took place in working the motor; so that from 35 to 40 per cent. of the work originally given out by the steam engine must be taken as the utmost useful effect on the rail.

It was estimated that to draw the carriage on the level ·714 horsepower was required, or if a second carriage was attached, ·848 horse-power would draw the two together. This would mean that, say 2 horse-power on the fixed engine would be employed to create the electricity, for producing the energy required to draw the carriage on the level.

The electric tram-car was quite equal in speed to those driven by steam or compressed air, and was characterised by its noiselessness and by the ease with which it was manipulated.

Assuming the car, by itself, cost the same as an ordinary tramcar, the extra cost relatively to other systems was stated as being, according to the following figures, viz.:—The Gramme machine cost £48, the motor £208, and the accumulators 2·25 francs per kilogramme (10d. per pound). To these must be added the cost of erection, and of switches for manipulating the current; as well as the proportion of the cost of a fixed engine to create the electricity.

The original programme of the conditions which were laid down in the invitation to competitors, as those upon which the adjudication of merit would be awarded, contained twenty heads, to each of which a certain value was to be attached; and in addition to these special heads, there were also to be weighed the following general considerations, viz.:—

a. The defects or inconveniences established in the course of the trials.

b. The necessity or otherwise of turning the motor, or the carriage with motor, at the termini.

c. Whether one or two men would be required for the management of the engine.

As regards these preliminary special points, the compressed air motor, as well as the Rowan engine, required to be turned for the return journey, whereas the other motors could run in either direction.

In regard to this, the electric car was peculiarly manageable, as it moved in either direction, and the handle by which it was managed was always in front, close to the brake. This carriage was the only one which was entirely free from the necessity of attending to the fire during the progress of the journey, for even the compressed air engine had its small furnace and boiler for heating the air.

All the motors under trial were managed by one man.

The several conditions of the programme may be conveniently classified in three groups under the letters, A, B, C.

The conditions under A are:—

1. Absence of steam.
2. Absence of smoke and cinders.
3. Absence, more or less complete, of noise.
4. Elegance of aspect.
5. The facility with which the motor can be separated from the carriage itself.
6. Capacity of the brake for acting upon the greatest possible number of wheels of the vehicle or vehicles.
7. The degree to which the outside covering of the motor conceals the machinery from the public, whilst allowing it to be visible and accessible in all parts to the engineer.
8. Facility of communication between the engineer and the conductor of the train.

In deciding upon the relative merits of the several motors, so far as the eight points included under this heading are concerned, it is clear that, except, possibly, as regards absence of noise, the electrical car surpassed all the others.

The compressed air car followed, in its superiority in respect of the first three points, viz., absence of steam, absence of smoke, and absence of noise; but the Rowan was considered superior in respect of the other points included in this class.

Under letter B have been classed considerations of maintenance and construction.

9. Protection, more or less complete, of the machinery against the action of dust and mud.
10. Regularity and smoothness of motion.
11. Capacity for passing over curves of small radius.
12. The simplest and most rational construction.
13. Facility for inspecting and cleaning the interior of the boilers.
14. Dead weight of the train compared with the number of places.
15. Effective power of traction when the carriages are completely full.
16. Rapidity with which the motor can be taken out of the shed and made ready for running.
17. The longest daily service without stops other than those compatible with the requirements of the service.
18. Cost of maintenance per kilometre. (It was assumed, for the purpose of this sub-heading, that the motor or carriage which gave the best results under the conditions relating to paragraphs 9, 10, 12, and 13, would be least costly for repairs.)

As regards the first of these, viz., protection of the machinery against dirt, the machinery of the electrical car had no protection. It was not found in the experiments at Antwerp that inconvenience resulted from this; but it is a question whether in very dusty localities, and especially in a locality where there is metallic dust, the absence of protection might not entail serious difficulties, and even cause the destruction of parts of the machinery.

In respect of the smoothness of motion and facility of passing curves, the cars did not present very material differences, except that the cars in which the motor formed part of the car had the preference.

In the case of simplicity of construction, it is evident that the simplest and most rational construction is that of a car which depends on itself for its movement, which can move in either direction with equal facility, which can be applied to any existing tramway without expense for altering the road, and the use of which will not throw out of employment vehicles already used on the lines; the electric car fulfilled this condition best, as also the condition numbered 13, as it possessed no boiler.

In respect to No. 14, viz., the ratio of the dead weight of the train to passengers, if we assume 154 lbs. as the average weight per passenger, the following is the result in respect of the three cars in which the power formed part of the car:—

$$\text{Electric car} \quad \ldots \quad \ldots \quad \frac{9{,}350 \text{ lbs.}}{154 \times 34} = 1{\cdot}78.$$

$$\text{Rowan} \quad \ldots \quad \ldots \quad \ldots \quad \frac{15{,}950 \text{ lbs.}}{154 \times 45} = 2{\cdot}30.$$

$$\text{Compressed air} \quad \ldots \quad \frac{22{,}000 \text{ lbs.}}{154 \times 56} = 2{\cdot}55.$$

The detached engines gave, of course, less favourable results under this head.

Under head No. 15 the tractive power of all the motors was sufficient during the trials, but the line was practically level, therefore this question could only be resolved theoretically, so far as these trials were concerned, and the table before given affords all the necessary data for the theoretical calculation.

As regards the rapidity with which the motors could be brought into use from standing empty in the shed, the electric car could receive its accumulators more rapidly than could the boiler for heating the exhaust of the compressed air car be brought into use.

As regards the steam motors, the following were the results from the time of lighting the fires:—

The Rowan—
In 34 minutes ... ... 3 atmospheres.
36 „ ... ... 4 „
(At this pressure the vehicle could move.)
40 minutes ... ... 8 „

The Wilkinson—
In 35 minutes ... ... 2 atmospheres.
40 „ ... ... 4 „
44 „ ... ... 6 „
47 „ ... ... 8 „

The Krauss machine required two hours to give 6 atmospheres, which was the lowest pressure at which it could be worked.

The results under No. 17, viz., the fewest interruptions to the daily service, class the motors in the following order:—Krauss, Electric, Rowan, Wilkinson, Compressed air. The chief cause of injury to the compressed air motor arose from the carelessness of the drivers, who allowed the steam boiler to be burnt out. Unfortunately these drivers were new to the work.

Under letter C are classed considerations of economy in the consumption of materials used for generating the power necessary for working.

TABLE.

Description of motor.	Total number of train miles run.	Total consumption of fuel.	No. of lbs. per train mile.
		lbs.	
Electric ...	2,358·9	14,786·	6·16
Rowan ...	2,616·9	14,498·	5·42
Wilkinson ...	2,473·3	22,000·	8·82
Krauss ...	2,457·8	22,726·	9·10
Compressed air	2,259·1	90,420·	39·48

TABLE.

Description of motor.	No. of places indicated on the cars, per mile run.	Consumption of fuel.	No. of lbs. of fuel consumed per places indicated per mile run.
		lbs.	
Electric ...	80,203·5	14,786·	·18
Rowan ...	148,399·6	14,498·	·09
Wilkinson ...	119,085·1	22,000·	·18
Krauss ...	108,983·9	22,726·	·20
Compressed air	128,189·3	90,420·	·69

TABLE

Description of motor.	No. of seats per mile run.	Consumption of fuel.	No. of lbs. of fuel consumed per seat per mile run.
		lbs.	
Electric ...	61,591·2	14,786·	·23
Rowan ...	135,928·8	14,498·	·10
Wilkinson ...	93,965·6	22,000·	·23
Krauss ...	86,039·9	22,726·	·25
Compressed air	132,732·7	90,420·	·66

19. Minimum consumption of fuel (either coke or coal), in proportion to the number of kilometres run, and to the number os places, assuming for the seats a width of at least sixteen inches for each person seated.

It must be borne in mind that the conditions of the competition required that a second car should be periodically drawn by the motor, and that the calculations which follow include the total number of miles run, the total amount of fuel, &c., consumed; and the total number of passengers which could be conveyed by each motor, during the total time that the experiments were being carried on.

As regards the figures in these tables, it is to be observed that the consumption of fuel for the electric car is, to a certain extent, an estimate; because the engine which furnished the electricity to the motor also supplied electricity for electric lights, as well as for an experimental electric motor which was running on the lines of tramway, but was not brought into competition.

20. Minimum consumption of oil, or grease, tallow, &c. (the same conditions as in No. 19).

TABLE

Description of motor.	Total number of miles run.	Total consumption of oil, tallow, &c.	Consumption of oil, tallow, &c., per train mile run.
		lbs.	
Electric ...	2,358·9	99·0	·038
Rowan ...	2,616·9	106·7	·038
Krauss ...	2,457·8	188·5	·073
Wilkinson ...	2,473·3	255·4	·101
Compressed air	2,259·1	585·2	·255

CONCLUSION.

The general conclusion to which these experiments bring us is, that, undoubtedly, if it could certainly be relied upon, the electric car would be the preferable form of tramway motor in towns, because it is simply a self-contained ordinary tramcar, and in a town the service requires a number of separate cars, occupying as small a space each as is compatible with accomodating the passengers, and which follow each other at rapid intervals.

But the practicability and the economy of a system of electric tramcars has yet to be proved; for the experiments at Antwerp, whilst they show the perfection of the electric car as a means of conveyance, have not yet finally determined all the questions which arise in the consideration of the subject. For instance, with regard to economy, the engine employed to generate the electricity was not in thoroughly good order, and from its being used to do other work than charging the accumulators of the tramcar, the consumption of fuel had to be, to some extent, estimated. In the next place, the durability of the accumulators is still to be ascertained; upon this much of the economy would depend. And in addition to this question, there is also that of the durability of parts of the machinery if exposed to dust and mud.

In England, with our depressed trade and agriculture, there is a great want in many parts of the country of a cheap means of conveyance from the railway stations into the surrounding districts; such a means of conveyance might be afforded by light railways along or near the road side, the cost of which would be comparatively small, provided that the expensive methods of construction, of signalling, and of working, which have been required for main lines, and which are perfectly unnecessary for such light railways, were dispensed with.

It is certain that this question will acquire prominence as soon as a system of local government has been adopted, in which the wants of the several communities have full opportunity of asserting themselves, and in which each local authority shall have power to decide on those measures which are essential to the development of the resources of its own district, without interference from a centralised bureaucracy.

Incandescent Lamp Tests.—Mr. Carl Hering's paper dealing with the results obtained by the Franklin Institute is of a decidedly practical character and will well repay perusal.

THE REIS TELEPHONE.

PROFESSOR EDWIN J. HOUSTON, who is publishing in the *Journal of the Franklin Institute* a series of interesting papers entitled "Glimpses of the Electrical Exhibition,"* writes as follows respecting the Reis telephone :—

In concluding the brief history we have given of Reis's invention of the articulating telephone, we have thought it advisable, as far as possible, to append the views of some of the leading scientific men in the United States concerning the position which, in their opinion, Reis occupied as regards the invention of the articulating telephone. The list is by no means exhaustive ; nor has any attempt been made to obtain the opinions of those known to be adverse to Reis. It fairly shows the error of the statement that the leading scientific men of America recognise and fully endorse the pretensions of Bell.

The following circular letter was sent, viz. :—

Hall of the Franklin Institute, Philadelphia, 1885.

My Dear Professor,—I purpose concluding my articles on the Reis telephone, with a publication of the opinions, as far as I can obtain them, of some of the scientific men in the United States, as to the part taken by Reis in the invention of the articulating telephone.

Will you therefore write me at your earliest convenience, your opinion as regards the following interrogatories, viz. :—

First. Please say whether or not in your opinion Reis was the inventor of the speaking telephone ?

Second. Whether, if it was a speaking telephone, it worked substantially in the same way as the Bell telephone, or not ?

Third. Whether the electrical current employed in the transmission of speech was an undulatory current in the same sense as it is in the Bell telephone, or not ?

Fourth. Whether Reis ever actually succeeded in transmitting articulate speech as he claimed ?

Fifth. Whether the defects in the Reis apparatus are to be attributed to his transmitters, or to a want of sensitiveness in his receivers ?

Sixth. Whether the modern transmitting telephones of the variable contact type are anything more than the Reis transmitters with carbon substituted for the platinum contacts ?

Thanking you in advance for your courtesy in the matter,

I am, very respectfully,
EDWIN J. HOUSTON.

Prof. A. E. Dolbear in answer to the above kindly sent me in addition to a very full reply by himself, a number of letters received by him from scientific men, referring to the same subject, with permission to publish the same.

Tuft's College, College Hill, Mass., *October*, 1885.

Prof. Edwin J. Houston—

My Dear Prof.,—I have taken great pains to learn what Reis did with his telephone and what is possible with it, and I think it possible that I have made many more experiments with it than Reis himself did. The whole interest in the present controversy centres in Reis's transmitter, as to whether it is, and was in Reis's hands, capable of so modifying an electric current, through the automatic action of sound vibrations, as to produce what is now called the undulatory current, and of transmitting articulate speech. Now the structure of Reis's transmitters is so well known that a detailed description is not needed. All of them (for he made eight or ten forms) were so made that sound vibrations of any sort should act upon a diaphragm, carrying an electrode, upon which rests with gentle pressure, either by a spring or by its own weight, another electrode, these being part of an electric circuit, the intent evidently being that the actual movements of these electrodes, when actuated by sound vibrations, should modify the strength of the current so that it should represent as nearly as possible the wave movements in the air. If Reis's apparatus was not *intended* to duplicate such air movements by changing the energy of the current by the transmitter, I can see no use for Reis's figures of compound sound waves and his extended explanations of them. Whether apparatus so made and used will so modify a current is simply a matter of fact and in no wise depends upon anyone's theory of electricity, or sound, or molecular action, or of make and break of circuit. It ought not to be lost sight of, nor kept obscure, although every effort has been made to divert attention from it, that Reis's transmitter like every other kind of transmitter acts *automatically* when it works at all, and its individual vibrations cannot be controlled by anyone. Whether there will be a make and break of contacts or not, depends upon the rate of vibration and the amplitude of vibration of the diaphragm. If the amplitude be great and the rate low, the electrodes will not separate, for the free one can follow the movements of the membrane. If the amplitude be small and the rate high they cannot separate ; in either case there will be only a variation of pressure of the electrodes at the point of contact. So much is purely mechanical and automatic, but it needs to be said and emphasised, for, first, it is true ; and second, because this was lost sight of by the Courts, and has cunningly been evaded by those interested in the denial of Reis's claims to be considered as the inventor and maker of the first speaking telephone. Everyone who has experimented with Reis's transmitter knows that it will transmit articulate speech, except a few, a very few, who have an interest in not knowing. I have known one such to find a convenient excuse for absence when he had good reason for thinking that by staying, his expressions of opinion would have to undergo revision.

Now Reis invented a device which he called *The Telephone.* He described its structure so that others could make similar ones, and in addition he undertook to explain throughout its mode of operation, a work which it is impossible to complete even to-day with all the advance in the knowledge of electricity and mechanics. It is in his explanation of the mode of operation of the instrument that he speaks of making and breaking the current. It might fairly be asked how Reis could absolutely know that there was a make and break for every vibration supposing that it did actually occur. He could not prove it, and, as a matter of fact, it is mechanically impossible that it should make and break the circuit for every vibration for complex sounds.

Let us suppose that we are in Reis's room, where his apparatus is set up, and we ask him how it is to be used ? He says to one at the transmitter "Make sounds of *any kind*, it will transmit them," and to the one at the receiver "simply listen at the receiver." The first sings and speaks, and the latter says he heard the singing and words. Ask Reis to explain how the thing is done and he talks about makes and breaks of the current at the movable contacts of the transmitter. But Reis, how do you know that it makes and breaks for every vibration when it is transmitting words ? Reis didn't and couldn't know. What Reis was doing, was helping his auditors to an easy conception of the possibilities of his apparatus, and I submit that at this day his explanation is the shortest and simplest for any who are not somewhat skilled in physics. I am not saying that it is not possible to transmit speech by a make and break circuit for every vibration, because McDonough with his wheel has demonstrated that it can be done, and has thus proved that Reis was right, if such a construction be put upon his words. What I am saying, is, that if Reis *intended* that his apparatus should make and break the circuit for every vibration, then he failed, for his apparatus won't do it. It works *automatically* when it works at all and does not depend upon the *intention* of the speaker to make and break for every vibration. In the Spencer case, Judge Lowell gave the famous decree that 100 years of Reis would not make a speaking telephone. The 100 years is up, however, and McDonough with his *make and brake* wheel says *hello,* easily recognised by Profs. Young and Brackett, and many others, as well as by myself.

When Sir Wyville Thomson sent home from the *Challenger* his observations on *bathybius,* Prof. Huxley sought the first print to say that he was mistaken when he gave the substance its name and philosophical importance—an example which a $20,000,000 monopoly could not afford to have followed.

Again, it is admitted everywhere that there is no *mechanical distinction* between the Reis transmitter and the Blake transmitter, and that the efficiency of the latter depends upon the employment of carbon where Reis used platinum. Does any one think that Reis would have explained his device differently if he had used the substitute ? or, that he would not have had a speaking telephone comparing well with any we have to-day ?

It has been affirmed again and again that if Reis's transmitter will transmit now, it is because we apply knowledge to it which has been acquired since 1876. Take then a Reis transmitter that has not been touched since 1864, if such an one can be found, and connect it properly in circuit with a battery and connecting wire. If it be spoken to will it act microphonically or not ? Any one having knowledge enough of the apparatus to be entitled to an opinion, who should say that it would not, would be entitled to admiration for his hardihood. If it will work microphonically it is because such action is *inherent in the mechanism* and not on account of any knowledge imported into it, and any such assumption is a fiction, warranted by nothing except the necessity for denying the right of the public to use that instrument for the purpose for which it was made. One may sing to it, may whistle or screech at it, but remember that if anyone hears a word from it the Bell Company is entitled to his head. "The law allows it and the court awards it."

But making no distinction between the description of a piece of apparatus and the explanation of its mode of operation, giving the merit of the invention to the man who properly explains it would make fine work throughout science. Let us see ! When Crookes made and exhibited those wonderful tubes called *radiometers,* he explained their action as being due to the direct action of light upon the delicately-poised vanes. He *intended* that the impact of light waves should propel the vanes, and they certainly rotate as he also *intended.* Afterwards Stoney and others, better acquainted with thermo-dynamics than was Crookes, gave a more consistent interpretation of the motion, but I have yet to hear that 100 years of Crookes wouldn't make a radiometer. Is it because there was no $20,000,000 behind it ? Brewster invented the kaleidoscope, but as long as he lived he explained its phenomena on the basis of the corpuscular theory of light. Brewster's claim was not denied. Was it because there was no $20,000,000 behind it ?

If Daguerre explained the action of light upon his sensitive silver plate as being due to the formation of a solar salt upon it, the degrees of shade depending upon the amount formed, he was altogether wrong, but the one who explained the chemical action upon the plate, made no claim to the discovery of photography. Was it because there was no $20,000,000 behind it? Let one invent a new galvanic battery cell and describe it, telling what solids and liquids to use and their proper disposition in the cell. Let him explain that it is his *intention* that the ammonia shall combine with the zinc, and the chlorine be set free upon the carbon. The battery shows when it is set up, that that evidently was the intention, for the elements are placed in proximity and are free to *if they will*. The courts may declare that what he invented was what he explained, not what he made—if there be $20,000,000 that want the invention.

---

* Philadelphia, 1884.

Grove invents a galvanic battery and describes its make up, and explains its action on the *chemical* theory of electricity; Bunsen improved it by substituting carbon for the platinum and explains the whole on the *contact* theory of electricity, which is endorsed by Sir Wm. Thomson and many other physicists. What Grove had in mind was to produce electricity chemically. Bunsen had in mind the correct conditions for generating it, and his battery exemplifies it. A hundred years of Grove will never make a galvanic battery, if there be $20,000,000 that want his invention.

Another point which has been made much of on one side, namely, that if Reis had succeeded in transmitting speech, that it is incredible that no more should have been heard of it, and that it is extremely unlikely that such a success should have remained uncredited for so many years as to be almost lost sight of. But the answer is at hand. It is not denied that Yeates, of Dublin, did transmit speech telephonically, in 1866, with his improved Reis apparatus. Did it attract any attention? Was it even chronicled? Why was no public mention made of it? Simply because it was considered a curious toy and not of commercial importance.

To sum up, then, in my opinion:—

1st. Reis invented a speaking telephone capable of transmitting words, that he intended it for that purpose and used it with success, for he says in his so-called *prospectus* when giving directions for using it "sing," "speak." He also says directly in one of his lectures, "*words were transmitted.*" This is also the testimony of a considerable number of those who were with him, Quinke, Messel, and others. One of the most eminent scientific men in the United States said to me: "The testimony of Quinke alone is enough to settle that point."

2nd. That Reis's transmitter works in precisely the same way, while transmitting speech, as do the modern ones, namely by what is called *microphonic action.*

3rd. That the only difference of any importance between the Reis transmitter and the modern commercial one, is in the material, carbon being substituted for platinum for an electrode, which renders it more efficient but does not change the method of operation.

4th. That the main reason why Reis obtained no better results than he did, was due much more to the lack of sensitiveness in his receiver than to defects in his transmitter. The weaker vibrations, though present, being so much diffused as to be often inaudible. The modern receiver is more efficient on account of its boxing. There is no principle or mode of operation in the modern telephone which was not known and embodied in instruments made for the purpose twelve years before the famous patent of 1876. This patent could not have been for a *new art*. The Bell Company knows all this as well as anyone, and is in constant fear that the courts will find it out. Ask a Bell man: "What is a Reis transmitter?" and he will answer: "One that will not transmit speech." "What is a Bell transmitter?" Ans.: "One that will transmit speech." "If a Reis transmitter transmits speech, whose transmitter is it?" Ans.: "Bell's."

To show that I am not alone in my opinion upon these points I append the opinions of other scientific men in the country to whom I applied, asking them to state what their views were upon Reis's telephone, and give me permission to quote them. As will be seen, there are not two opinions about it any more than there are two opinions as to whether the earth is flat, though there may be here and there a man like "Parallax" in England who is stoutly defiant.

Yours truly,

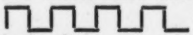
A. E. DOLBEAR.

Physical Laboratory of Washington University,
St. Louis, *May 21st*, 1885.

Prof. A. E. Dolbear—

Dear Sir,—Replying to your question concerning the difference between the action of the Reis transmitter and the ones now in use by the Bell Company, I reply that I cannot see that there is any difference in the method or manner of working. It is a source of amazement to me that the courts have decided differently, and I regard it as a very great disgrace, arising I hope from ignorance.

I do not think that either Reis or Bell were perfectly successful in describing the working of the transmitter, but of the two Reis is ahead.

Reis describes clearly the character of sound waves, and wishes to have these sound waves act upon his transmitter so as to produce changes of a similar character in the electrical apparatus, in order that these sound waves may be again reproduced by his receiver. He seems to have fixed his attention upon the magnetic field, or magnetic condition of his receiver, and knowing that a break in the circuit did not abruptly extinguish the current, by reason of the self induction of the wire coils, and that the closing of the circuit was followed by a gradual rise to the maximum current, he thought a make and break between spring contacts would accomplish what he clearly saw was necessary. He knew also that similar retardation occurred in the magnetisation and demagnetisation of the iron core. He seems to have understood all this much more clearly than Bell, who draws lines like this  to represent the case of a make and break circuit.

Reis seems to have intended to produce wave-like changes in the magnetic condition of his receiver, and this is precisely what is necessary, *and it is precisely all that is necessary, in order to transmit articulate speech.*

When a circuit containing an electro-magnet is opened and closed, the changes in the magnetic condition of the magnet are necessarily wave-like, and Reis may have thought, therefore, that a make and break would serve to accomplish the result at which he aimed. But we know now that under the conditions which are supplied in the Reis transmitter, the wave forms are not of the proper shape to reproduce speech if the circuit is opened and closed at the working contact. The fact is that when the Reis instrument does transmit speech, the circuit does not open and close, and whatever Reis may have thought about it, it did not make and break the circuit when it worked successfully in his hands. It worked by varying the resistance at the loose contact, precisely as the "modern" instruments work to-day. The result at which Reis aimed was to produce the proper variations in the magnet strength. He succeeded in doing this in an imperfect manner. But that he did succeed in doing it I cannot doubt. His main weakness was in the receiving instrument, which was not sensitive enough.

What I have written here seems so clear and evident to me, that I cannot avoid thinking ill of a man who says it is not true. Unless other considerations prevent, I class him among those who say the earth is flat.

I am not in any way financially interested in any kind of telephone, but I think it is time for scientific men to speak out on this subject, and, so far as I happen to know, they are practically of one mind.

It is not very likely to influence the legal decisions, but it may at least relieve American scientific men of the disgrace of giving even tacit countenance to a monstrous imposition.

Very sincerely yours,

FRANCIS E. NIPHER.

3208, Race Street, Philadelphia, Pa., *July 22nd*, 1885.

Prof. A. E. Dolbear—

Dear Professor,—(1.) There *will* be a telephone report.

(2.) I had supposed, without pretending to be a specialist, that there was but one way a telephone *could* work, and that, therefore, Reis had the idea which was made available later. I have not made that accurate historical research without which I simply should hold my judgment in suspense. Yours truly.

(Signed) LEONARD WALDO.

Yale College Observatory.

STATEMENT.

Having received a Reis instrument, same as "Fourth Form" described in Reis's own paper "On Telephony" in the annual report of the Physical Society of Frankfort-on-the-Main for 1860-61 (see p. 20 of Thompson's "Reis Inventor of the Telephone"), I had no slight curiosity to know whether it would or not transmit speech.

I connected my lecture room with the physical workshop, using about 20 lbs. of 18 office wire, one Grenet cell, and two Bell receivers in circuit. One of the receivers was located at opposite end of line in shop, while the other and Reis transmitter with the battery were on my table.

After securing fine *singing* adjustment (by *singing* I mean one that would cause the Bell receiver at my ear to hum freely when talking with the Reis), I found that my assistant in the shop could carry on conversation quite readily—so much so that we were both astonished at the results. He called others into the shop, and in more cases than one we fooled the hearers so completely that they supposed that we were using the regular Bell outfit at my end of the line.

We still use the circuit for communication between lecture room and shop without difficulty.

Surely no one who had ever seen a Reis telephone could claim thereafter to have invented the system of transmission of speech by electric pulsations or undulations.

(Signed) JOHN B. DEMOTTE, *Prof. of Physics.*

De Pauw University, Greencastle, Ind., *July 21st*, 1885.

Sheffield Scientific School of Yale College,
New Haven, Conn., *June 3rd*, 1885.

Prof. A. E. Dolbear—

Dear Sir,—It is certainly my impression that Reis's telephone embodies all the essential features of the systems now used, and that if it had been generally known, the exclusive patents which have proved so valuable would not have been granted; but I am unable, under the pressure of annual examinations and much other work, to undertake to either write out a carefully formulated opinion, or to make experiments in a field which is now chiefly of a historical or technical interest,

Yours very truly,

(Signed) CHARLES S. HASTINGS.

Ohio Wesleyan University, Delaware, O.,
June 30th, 1885.

Prof. A. E. Dolbear, Tuft's College, College Hill, Mass.—

Dear Sir,—I have been experimenting with a telephone made according to the description that Reis gives of one that he made. It is an exact pattern of the one described by Reis. I am irresistibly forced to these conclusions from all the knowledge I can gain on the subject, viz., that Reis did invent a speaking telephone, and that as he invented and constructed it, it is capable of transmitting articulate speech, and that it did so in Reis's hands, and that as a transmitter it substantially works in precisely the same manner as any modern transmitter does when transmitting articulate speech. Reis's invention, the telephone, was undoubtedly what he made, he probably did not fully understand its mode of transmitting speech, nevertheless he made a telephone that in my hands fully and completely transmitted entire sentences. Reis's description of the operation of his instrument is one thing and its work another in my opinion; his invention is the telephone, an articulate speech transmitter, and not a description of its operations.

I am, very truly yours,
(Signed) W. O. SEMANS,
Prof. Chem. and Physics.

Columbia College, N.Y., *May 28th*, 1885.

A. E. Dolbear, Esq.—

Dear Sir,—In answer to yours of April 29th, I would say, that in my opinion the Reis transmitter, when made and adjusted as the maker intended, is capable of transmitting articulate speech, operating like the Blake transmitter, the action being microphonic, and differing only in efficiency from modern instruments of this class; in other words, Reis in my opinion invented a speaking telephone, operating with precisely the same kind of currents now so commonly employed, the defect of the apparatus being in the lack of sensitiveness of the receiver. Very truly,

(Signed) OGDEN N. ROOD,
Prof of Physics in Col. Col.

Department of Physics, Cornell University
Ithaca, N.Y., *June 1st*, 1885.

My Dear Professor Dolbear,—I am under obligations to you for showing me, while you were in Ithaca last week, a genuine Reis, by which, when used as a transmitter in connection with a Bell magneto telephone as a receiver, conversation could be carried on with nearly the same facility as by the Blake transmitter. The experiment showed conclusively that the Reis telephone, with only platinum contacts, not only can transmit speech, but does so so clearly and distinctly that if we had not something better it would be considered a thoroughly successful transmitter.

Had Reis succeeded with his receiver as well as with his transmitter the speaking telephone would have been in universal use 10 years earlier than it was. Yours very truly,

(Signed) WM. A. ANTHONY, *Prof. of Physics.*

Princeton, N. J., *May 28th*, 1885.

My Dear Prof. Dolbear,—As to the matter we talked about, the case stands about thus in my opinion. Reis set out to make an instrument that would convey sounds electrically; there is no evidence that there was in his mind any limitation whatever as to the kind of sounds to be conveyed, and there is on the other hand considerable and conclusive evidence that he had in mind articulate sounds as well as musical tones. He constructed apparatus which would communicate musical sounds very well, and articulate speech partially; that is, he occasionally got speech through it; but not hitting upon *carbon* as the material of his transmitter electrodes, his success as regards articulate speech was not complete or satisfactory.

Being no business man, and looking at the thing from a scientific rather than a business point of view, he took out no patents, and made no attempts that I ever heard of to introduce his invention as anything more than a piece of interesting scientific apparatus. He did *publish* his results somewhat widely, and his instruments were put on sale as scientific apparatus.

His instruments, just as they came from his hands, will talk now, if manipulated carefully enough, and if *improved* by merely inserting a bit of carbon at the loose contact of the transmitter, would to-day answer satisfactorily for telephonic business; though of course anyone would admit that the receivers and transmitters now in use are better than such an apparatus would be. But his *receivers* will any of them operate fairly well with our modern microphone transmitters, and his *transmitters*, fitted with carbon electrode are excellent, even judged by the latest standard.

The fact that he spoke of his transmitter as working by "opening and closing" the circuit, and did not enter into any discussion as to the question of the completeness of the "make and break" in the transmission of words, does not appear to me to justify at all any attempt to deprive him of the credit of his invention. Perhaps the question did not raise itself in his mind, and perhaps it did; but however that may be, he invented an apparatus that would talk—rather capriciously it is true, for want of carbon, but still, when exactly adjusted, it would talk until the adjustment was disturbed. Nor, I think, can there be any question that the action of his apparatus, when thus talking under successful adjustment, is precisely the same as it would be if one of the electrodes was tipped with carbon, and the same also as the action of any of the ordinary carbon transmitters now in use.

As to the precise nature of the action at the "loose contact" of a transmitter, I think no one is yet entitled to speak with confidence. That it *may* consist of actual "makes and breaks" of the current in the ordinary acceptation of the term is proved to my satisfaction by McDonough's revolving wheel experiments; that it *may* consist on the other hand in a rapid variation of the strength of the current without complete "makes and breaks" is of course possible, since in the magneto telephone this is unquestionably the way the current acts. But as I view the matter, *whatever* the action may be, no man has a right now to claim exclusive ownership of it for having discovered an explanation of it, even if his explanation should turn out to be more accurate and exact (which need not yet be admitted) than that of the man who first used that action for the transmission of words. If Mr. Bell's explanation proves correct, well and good, he deserves *scientific credit* for it, but not *patent right* in it, as against Reis.

I do not know that this letter will answer your purpose, but if you can make any use of it, it is quite at your service to do what you like with it.

Very truly yours,
(Signed) C. A. YOUNG.

U. S. Department of Agriculture.—Division of Chemistry.
Washington, D. C., *May 21st*, 1885.

Prof. A. E. Dolbear, College Hill, Mass.—

Dear Sir,—I have had the pleasure of testing a model of the Reis telephone, and was surprised at the distinctness with which his transmitter allows the passage of articulate speech. In the trial which I made of the instrument, the distinctness of the transmitted conversation was as marked as that of the ordinary telephone.

It seems to me that the only difference between the Reis transmitter and those of the modern telephone is in efficiency and not in principle. The trouble which Reis encountered in his experiments I am now convinced was in his receiver and not in his transmitter. Had he been provided with a receiver as delicate as those now in use, the telephone would have been a commercial success 20 years ago.

The transmitter which was used in the trials made in my presence was an exact reproduction of the one described in Reis's original drawings; and the result of the experiment leaves no doubt in my mind that Reis was the inventor of a speaking telephone.

Messrs. Richardson and La Dow, who were with me during the experiment, were also much pleased with the excellent action of the instrument.

Respectfully,
(Signed) H. W. WILEY.

Ann Arbor, Mich., *June 17th*, 1885.

Prof. A. E. Dolbear—

My Dear Sir,—I can confidently assure you that I have heard speech transmitted in a satisfactory way by means of a Reis's transmitter. The instrument was a careful copy of one of the forms figured in Thompson's book on Reis's telephone, and the results were nearly or quite as satisfactory as I usually obtain with more recent forms of patented instruments. Sincerely yours,

CHARLES K. WEAD,
Prof. Physics, Univ. of Mich.

North-Western University, Evanston, Ill.,
Prof. A. E. Dolbear— *Oct. 10th*, 1885.

Dear Sir,—Respecting the Reis telephone, the evidence appears to me to be entirely conclusive on three points:

First. The Reis telephone, or a faithful copy of it, transmits speech to-day, "with a distinctness sufficient for everyone" to understand plainly.

Second. It transmitted during the lifetime of Reis himself. Of this we have evidence from contemporary printed accounts of its performance, and from *ear-witnesses*, if the word may be allowed.

Third. Reis designed the "*telephone*" to transmit speech. His own account of "Telephony," published in 1862, is unmistakeable on this point.

Philip Reis conceived the idea of transmitting speech and music by galvanic electricity, and constructed an instrument that actually did this, even though the laws of the composition of vocal and other sounds were not at that time well understood; and he should certainly have the credit arising from so great an invention.

Very truly yours,
(Signed) H. S. CARHART, *Prof. of Physics.*

Boston, *Oct. 10th*, 1885.

Professor A. E. Dolbear—

Dear Sir,—In reply to yours asking for information concerning my knowledge of Philipp Reis and his relation to the telephone, would say that I had, previous to 1881, become so much interested in the subject that, happening to be in Germany, I resolved to visit the field of his labours that I might not only satisfy my curiosity but also judge for myself from the testimony of living witnesses, and from apparatus which Reis has left of the character of the work accomplished by him. Near the centre of the small village of Friedrichdorf, and directly opposite the post-office, stands the modest house where Philipp Reis formerly lived and which is still occupied by his family. There remain many evidences of his former presence. In the casement of the sitting-room window, electrical binding posts with wires leading to a room in the rear may still be seen. Placed there by Reis himself and used by him in making probably the greater part of those important investigations in the endeavour to perfect his apparatus for the transmission of speech. This was his aim, and anything short of that he considered of little importance—so said Mrs. Reis. A short distance further up the main street stands the Garnier Institute, where Reis as a teacher displayed a wonderful ingenuity in devising apparatus for illustrating the usual experiments in Physics and also evinced, as shown by several pieces in the collection, an originality in invention and research of a very high order.

Prof. Leon Garnier, Principal of the Institute, said he had often witnessed Reis's telephone experiments and repeated many words and sentences which he himself had heard through the apparatus.

I was next introduced to Herr Henry Holt. He thus related his first successful experience with the telephone. "I had been listening a long time, and heard nothing intelligible, when suddenly I plainly heard the words, '*I am through; come up.*' I went up, and was considerably surprised to find that that was exactly what Reis had said, and he then explained to me that the speech had been transmitted by the electric current." Mr. Holt said Reis was at the time highly elated over it. After that, he listened with much greater faith, and hence with closer attention, and, on many occasions, heard words and sentences. Reis was evidently sorely tried by the incredulity of those who in the earlier experiments assisted him, and who, consequently, were very careless and inattentive listeners. Many a joke did poor Reis encounter from his co-labourers and associates, but he eventually silenced them all; and, although they could not realise its importance, they yet recognised the fact that Reis had then made a speaking telephone, and that it was to him as the inventor of the speaking telephone, that the monument in the cemetery at Friedrichdorf was erected by the Frankfort Society. Many have, as you know, for selfish reasons, endeavoured to belittle that testimonial by claiming that it was the invention of the *musical* telephone, which it was intended to commemorate. Owing to the difficulty of making such delicate tests before a popular audience, the transmission of musical tones was given prominence at his lecture. It was with much pleasure that I visited the very building and room at Frankfort in which that famous first lecture of Reis on the telephone was given, and strolled through the garden across which the wires on that memorable occasion were stretched.

The original manuscript in Reis's handwriting had previously been shown to me by Mrs. Reis; she still has it, I believe, in her possession.

At the shop and factory of Albert, philosophical instrument maker, I learned several interesting facts. The Reis transmitter known as the *collar box* pattern was shown to me by Mr. Albert and he said, as seems probable, that it was made previously to the *square box* and subsequent to the bored block pattern. It seems to me that this must have been the order of sequence. I feel sure that Reis did not employ Albert until after his lecture before the Frankfort Society, where the *bored block* transmitter was used; moreover, Albert says he made the collar box pattern himself, and this more nearly resembles the *square box pattern*; involves the same ideas; and seems like its crude beginning.

The *collar box* and the *square box* patterns were, however, not intended as superior instruments, *i.e.*, instruments from which Reis could himself obtain better results, but were so made because they were automatic in their action. At that time there was a call for his apparatus and Reis reasoned that an instrument which dispensed with such delicate adjustment as the *bored block* required would be better to put into the hands of the unskilled experimenter.

Mr. Albert said there was a great difference in the performance of the transmitters even when made as nearly alike as possible. I have myself verified this experience of Mr. Albert. For example I have had a dozen of each of the parts of the *bored block* transmitter made and placed in piles by themselves each piece like its neighbour, and interchangeable like the parts of a Waltham watch. When set up, taking a piece from each pile, for each instrument, the transmitters could not be told apart except by the number stamped upon them. Upon testing them a great difference was observed in their performance. With some, talking could be transmitted at once, while others needed much adjusting and patience before they would do well even if they ever would. This explains why the various early writers concerning these telephones differ as to their capabilities. Some by chance obtained good instruments, others not so good although all seemed alike.

It was my good fortune, while in Europe, to obtain a pair of instruments which were exact fac-similes of those now held by the German Government and claimed to have been the first set sent out by Reis.

The transmitter was of the square box pattern and the receiver (the knitting needle pattern) corresponded to Pisco's minute description.

With these instruments I have at various times performed many hundred experiments. I have heard both words and unexpected sentences as plainly as with the best modern instruments. When so transmitting speech, the transmitter does its work in precisely the same manner as does the Blake, Edison, or other ordinary varying-contact transmitter. The current produced has variations precisely similar to the variations caused by carbon transmitters. By substituting a small piece of electric light carbon for piece of platinum foil, which terminates one of the electrodes of the *bored blocks* transmitters, I have obtained an instrument as good and as practical as a Blake transmitter. Indeed, the latter is then but a close imitation of the *Reis bored block*. With a transmitter thus modified, the Reis knitting needle receiver is a good practical receiving telephone. Its tones are clear and articulation excellent.

As the result of my investigations and experiments, I am thoroughly convinced that the Reis apparatus can and in the hands of Reis did transmit articulate speech, and that Reis should and will go down in history as the first and original inventor of the Electric Speaking Telephone.

(Signed) H. C. BUCK,
Electrician, 70, *Washington St., Boston.*

(*To be continued.*)

DEEP-SEA LIGHTHOUSES AND TELEGRAPH STATIONS.

ABOUT three years ago Mr. C. Anderson, of Leeds, read a paper before the Society of Engineers on a system of deep-sea lighthouses, intended to render navigation safer and communication with vessels in distress easier. That gentleman proposed to construct lighthouses in the form of a large cylinder of riveted ironwork, about 36 ft. in diameter and 290 ft. in length, and consisting of three parts. The upper portion was to rise 140 ft. out of the water, and to be in shape and detail constructed like the towers of an ordinary lightship. The central part was to be rendered unsinkable by packing it with material lighter than water. The lower portion, extending to 150 ft. below the water line, was to act as a ballasting and steadying power.

Recently a rival scheme has been brought forward and practically tested with a working model, which bids fair to effect similar results by means of a combined floating telegraph station and lightship, which is the invention of the late Captain Moody. The model, which has been constructed at the Barrow Shipbuilding Company's yard, resembles a floating telegraph station in almost every particular, and has a hull of a peculiar shape, being constructed with four equal rays or projections proceeding from a central circular deck, protected by an iron bulwark. In fact, the actual vessel may be said to be something like a square cushion. 80 ft. by 80 ft., with the sides indented. Openings are made through the deck to the interior of the vessel for companion ways and skylights, as well as scupper-holes round the bulwarks to take off any water that may be shipped in a storm, although, as a matter of fact, it is claimed for the novel vessel that, even in the heaviest seas, no water is shipped, on account of its great buoyancy. There is also said to be no danger whatever of foundering, owing to the clearing valves and the divisions into numerous water-tight compartments, and other contrivances. The vessel is also constructed to deflect the waves as they strike, instead of allowing them to break upon the deck. The vessel is to be held fast by four strong cables running from the curvatures between the rays, and if the vessel is to be moored in mid-ocean, these cables will be attached to cylinders or buoys sunk to a certain depth, and from these, again, will be cables with anchors. If the vessel is placed in any position near land, four cables with as many anchors only are required. The telegraph cable is to run through a well in the centre of the vessel, and cannot, it is stated, by by any possibility become twisted with the cable chains. If the vessel is also to be used as a lightship, the light is placed in an ordinary lighthouse lantern, placed on the top of a substantial lattice-work tower, 60 feet above the water-line, and made of steel, with ladders running up the inside. Steel wire ropes from the hull to the top act as stays to the towers. The vessel is to contain ample accommodation for the crew, as well as store and other rooms.

It is claimed for the new vessel, with its immense strength, its great floating surface, its arched form and water-tight compartments, which latter would act as bulk-heads, its great buoyancy, its power of deflecting the waves, and its whole general construction, that it is the best possible form of vessel for a floating lightship and telegraph station. The present form of vessel can only be made to swing with the wind and tide if placed in a seaway, but Captain Moody's can be moored in a triangle or by four cables, and can be kept in position whatever may be the state of wind or tide.

The trials which were made with the model last week off the yard of the Barrow Company are stated to have given great satisfaction, the vessel behaving splendidly in a very rough sea, taking each wave with an easy motion and shipping no water. The model is to be submitted to the Trinity Board, and later on to be sent to the Shipping Exhibition at Liverpool.

REVIEWS.

Magnetism and Electricity. For the Use of Students or Schools and Science Classes. By H. C. TARN, M.C.P., F.S.Sc. W. & R. Chambers: London and Edinburgh.

The object of this book is to make clear to a beginner all that is necessary for him to know in order to "make sure" of a first class in the elementary examination of the Science and Art Department. The author does not claim that it "supplies a want," but he leaves the work to be judged by its own merits; the latter, we consider, are decided. The work is written in a colloquial style which has its advantages, although in several cases it verges upon the "penny-a-line" of a very commonplace description; thus in the chapter on Telegraphy, which consists of two pages, we have the following rhapsody: "Signals may now be flashed through space with a velocity equalled only by the speed of light; time and distance become annihilated; and the remotest corners of the globe, if bound together by the civilising belt of wire, exchange their communications as though they were the nearest neighbours. Genius and invention have subdued all the difficulties connected with electric transmission; and nearly the whole of the civilised world is now *girdled* with the *vehicle* (the italics are our own) of intercourse." ! ! ! ! At the end of this chapter we have the following extraordinary antithesis: "The needle telegraph only *transmits* signals it does not *record* them." The author's notions on the use of amalgamated zinc in batteries seem a little foggy; thus we are informed that "the action of the mercury on the zinc produces a uniformity in the hardness of its surface, *enables the hydrogen to carry off with it the metallic impurities* which tend so much to the development of local currents."

L'Electricité à l'Exposition Universelle d'Anvers. Par CHARLES MOURLON. 2nd Edition. Bruxelles: Imprimerie du Mouvement Industriel Belge, 6, Rue de Poinçon.

This book is decidedly a commendable publication, and much information will be found in it which has not been published elsewhere except in a fragmentary condition. The illustrations are numerous and for the most part well executed.

NOTES.

The Electric Light in Ironworks.—The electric light is now being extensively employed in the ironworks of South Staffordshire. The arc system, which is used in some of the chief steelworks of the kingdom, has been found unsuitable to the low roofs of the Staffordshire mills, where it is necessary that the roller should have a gas jet, or some similar light close to the rolls, but the incandescent or glow lamp system is found to answer admirably. The cost of maintenance, after allowing for the interest on capital outlay on plant, is only about half that of gas. The latest works at which the light has been adopted are the extensive steelworks of Messrs. John Lysaght, Limited, of the Swan Garden Ironworks, Wolverhampton. The whole of their works, including foundry, fitting shops, and offices, as well as pig yards, bar banks, and canal wharves, are well lighted up by means of the incandescent lamp. Recently the light has been required as much as 18 and 19 hours out of the 24, yet all has gone on well. For sheet rolls and shears the light is all that is required; for the stocktaker's examination it answers admirably; and for yards and wharves, though less brilliant than the arc lamp, it serves exceedingly well. The current is generated by two compound-wound dynamos, made by the Elwell-Parker Company, Wolverhampton. There are 380 lamps upon the two machines, 60 of them being single lamps of 95 volts, and 320 running in pairs at 48 volts. The dynamos are driven at 950 revolutions per minute by an ordinary high pressure horizontal engine, running at 90 revolutions, and supplied by steam at 40 lbs., raised by the waste heat from the heating and puddling furnaces. The plant has cost £616. At Messrs. E. T. Wright & Sons, Monmoor Ironworks, Wolverhampton, the system is also in use. One-half of the extensive works has thus been lighted up, and the installation is running as steadily now as the day it started. In this case the dynamo generating the current is, with a small engine to drive it, placed upon the top floor of the mill engine house, and the engineer of the turn looks after it without trouble. A third example is that at Messrs. George Wilkinson & Co.'s new sheet mill at Tividale. Here the dynamo is driven from the flywheel of a small engine which drives a pair of edging rolls for grinding, fettling, &c., and which the mill engineer also looks after. At these several works there is no provision for storing the electricity, nor has the need of it been felt. In several other large manufactories storage cells are employed, that the current may be used during the night which has been produced in the day. But in an ironworks storage is practically unnecessary. The steelworks at Bilston, of the Staffordshire Steel and Ingot Iron Company are also lighted up by electricity. The dynamo machines at all the works have been made by the Elwell-Parker Company, and the installations have been effected by Mr. G. B. Wright, of Wolverhampton, who has also lighted up the Varnish Works of Messrs. Mander Bros., of the same town, and the large galvanising works of Messrs. Walker Bros., of Walsall.

Electric Light for Scarf Pins.—We shall be glad if some of our readers will inform us which battery is considered best suited for use with the small incandescent lamps inserted in jewelry such as scarf pins.

Electric Lighting in the Turkish Navy.—A telegram from Constantinople announces that great activity is exhibited in the dockyard there, and that contracts are being made for the supply of electric lights.

Electric Lighting of Steamers. — The *Gascoyne*, a new Transatlantic liner, which has just been launched at La Seyne, near Toulon, and which will be the largest vessel of her kind in the French navy, is to be lighted by electricity.

Electric Lighting in the Straits Settlement.—*The Colonies and India* remarks that the introduction of the electric light into the Straits may now be accepted as an accomplished fact. Mr. E. J. Wells has exhibited the latest form of the incandescent lamp at his works in River Valley Road, and he was expecting the suitable machinery from England in order to exhibit the more powerful arc lamp. Mr. Wells is forming a company to be called the "Singapore and Straits Electric Light Company," for the purpose of furnishing the necessary capital to carry out the lighting of private dwelling-houses and public buildings in the Colony and the Native States on an extensive scale, and he has already obtained from the Municipal Commissioners a concession of the right to lay wires in one district of the town of Singapore. It is a curious circumstance that the same gentleman introduced gas into the Colony about 24 years ago.

Electric Light on the Purchase-Hire System.—In the cases of a large number of mills, factories, hotels, private houses and other buildings, although the adoption of the electric light would be a decided improvement and probably a saving of current expenditure as well, yet the owners do not feel justified in sinking the capital required for the purchase of the necessary machinery. With the view of meeting the requirements of those who are thus situated, the Anglo-American Brush Corporation has, very wisely we think, adopted the plan of supplying electrical plant on terms of deferred payments so as to enable those who desire it, to obtain all the requisites for an installation without immediately incurring a large capital outlay. The plan is to distribute the total cost of the plant over periods varying from one to three years, interest according to the period of hire being added to the net cash price of the machinery. Further particulars will be supplied to any applicant by the Secretary.

Electric Lighting in Glasgow.—A special correspondent of the *Gas and Water Review* states that it has been resolved that the new Municipal Buildings of Glasgow, now in course of erection, and which will ultimately cost about half a million sterling, are to be illuminated with gas, and also partly with electric light. Provision is to be made, and pipes are to be laid, for lighting with gas throughout the entire buildings; but, in addition, the electric light is to be supplied to the Council hall, the banquetting hall and saloons adjoining, the telling rooms of the Gas and Water offices, the principal staircases and corridors, the saloons on the upper floors, the Lands Valuation office, and the quadrangle. The correspondent further remarks: "The electric light appears to give satisfaction at our various railway stations, but for the lighting of public works and offices it is not so popular in Glasgow, at least, as it was a year or two ago."

Electricity and Gas.—The gas lighting journals, or some of them, are adopting a more sensible attitude as regards the electric light than formerly characterised them, as will be gathered from the following remarks which we cull from last week's *Gas and Water*:—"Now, whatever may be our feelings or interests, we must admit that there are many purposes for which the electric light is better fitted than any other form of artificial light. For example, the magnificent nightly illuminations at the recent Inventions Exhibition could not have been equalled by any other means; and, for decorative purposes generally, the electric light stands unrivalled for beauty and possible diversities of application. In the lighting of hotels, theatres, public halls, shop windows, and other places where, notwithstanding extra cost, it pays as a means of advertisement, it has an extensive sphere for employment. Then, for many temporary purposes, where work has to be carried on at night, it is often the only form of light that would be practically available. Instances of this are to be seen at the Tay and the Forth bridges, and recently one was supplied in London, during the building of the new music hall opposite the Criterion. The above are facts, and it would be foolish to shut our eyes to them. The gas industry in future will have to face the electric light not as an erratic meteor, but as a sober and steady competitor. On former occasions we have duly chronicled the failures of the electric light, but it is equally our duty to record its progress when that is genuine. Although, as sensible men, we must accept accomplished facts, and forecast with such ability as we possess the probabilities of the future, there is little cause for discouragement. Notwithstanding the advances of the electric light for special purposes, the prospects of its introduction for ordinary use seems as remote as ever, and even the most sanguine electricians have ceased to predict its general adoption in lieu of gas. It is true that the position and prospects of the gas industry, in its lighting department, will be interfered with to some extent, but this loss will be more than counterbalanced by the profits arising from the extra sale of gas to be used for other purposes than lighting."

Progress of the Telephone.—In one of his current Lowell Institute Lectures, Mr. Thos. D. Lockwood gives some interesting figures in regard to telephonic industry and invention. The growth of the telephone is shown in the fact stated by him that, in August, 1877, the number of instruments in use in America was only 780, while in February, 1880, there was 60,800; 249,700 in 1883, 307,010 in 1884, and in February, 1885, 325,574. There are about 18,000 in Canada, and 13,000 in Great Britain. The number of exchanges in America has grown from 100 in 1880 to 782 in 1885, and in January of the present year there were 137,223 miles of telephone wire in the country. There are 5,168 persons furnished with employment by the exchanges. More different patents have been issued on the telephone than in any other single line of invention in the country. The total number for the ten years is 1,521.

Unauthorised Telephone Poles.—On Monday, at the Southwark County Court, his Honour Judge Holroyd and a jury were engaged in hearing a case in which Mr. William Wilcocks Oliver sued Mr. George Driver, manager of the British Telegraph Company, and Messrs. Burt, Boulton and Haywood, contractors, for £50 for wilful trespass upon the roof of plaintiff's premises, 15, Dockhead, Southwark, and placing thereon in 1881, telephone poles and wires without his knowledge or consent, and in so doing injuring the premises. The plaintiff, in the course of his examination, stated that his roof was very much injured, and he could not let the upper part of his premises for nearly four years, when he found that the defendants had caused the mischief through the General Post Office. The defendants practically admitted their trespass, and paid £9 into court, and evidence was given on both sides as to the extent of the plaintiff's loss. In the end the jury found a verdict for £20, inclusive of the sum paid into court. Costs were allowed.

Telephone Extensions in Scotland.—The Johnstone Town Council has had under consideration the application of the National Telephone Exchange Company for permission to erect poles to carry wires into the district. No objections being raised, the clerk was instructed to intimate the Board's concurrence. Arrangements, we learn, are all but complete for extending the telephone from Dumbarton to Helensburgh, and thence to St. Lord, Provost Ure's Mansion, Cairndhu. It may interest our readers to learn that it is 23 years since the telegraph was introduced to these towns by the British and Irish Magnetic Telegraph Company, under a five years' revenue guarantee.

The United Telephone Company.—When will the officials of this company see the error of their ways? Complaints as to defective service are constant, and amongst the most recent we quote the following editorial from the *Financial News*:—"The United Telephone Company seems to be completely upset by the severity of the weather. Complaints are heard on every side that subscribers are unable to communicate with each other, and the frequent ringing up of wrong numbers really makes the instruments a nuisance instead of a convenience. Considering the liberal pay that it receives, the United Telephone Company ought to manage to give a better service."

The Invention of the Quadruplex Telegraph.—The United States Commissioner of Patents has recently decided that the first and original inventor of the quadruplex system is not Thomas A. Edison, but one, Dr. Henry C. Nicholson, whose patent rights are held by the Western Union Telegraph Company. Had Edison's claims been maintained, the invention would have been open to the public, as in 1875, Edison took out a five years' patent in Canada, this circumstance rendering it for ever impossible for a valid patent to be issued to him in the United States covering the same ground. The patents have still to undergo the searching scrutiny of a court of equity, and it is expected that Mr. Edison will take a prominent part in the controversy; if they are adjudged valid, the Western Union Company secures a monopoly for seventeen years to come for what is described as one of the most profitable inventions of the present day.

Italian Telegraphs.—We have received a bulky volume containing statistics relating to the telegraphic service in Italy for the year 1884. Minute details appear to be given of the number of telegrams received at and transmitted from every office, whether the telegrams are private or government messages, the apparatus used at each office, and many other matters which are no doubt interesting to those concerned in the administration of the telegraph service.

Telegraph Revenue.—The receipts on the telegraphic service from April 1st, 1885, to January 16th, 1886, amounted to £,1,405,000, against £1,420,000 received from April 1st, 1884, to January 17th, 1885.

How Tyarsome !—Mephistopheles had an unexpected delight at the Lyceum lately. Mr. Tyars, playing Valentine for the first time, says the *Weekly Dispatch*, forgot to attach the electric apparatus to the handle of his sword. The consequence was that in the duel with Faust every time his weapon was touched by that of Mephistopheles the current ran up his arm and playfully tickled his funnybone. This must have vastly amused the Devil, but Mr. Tyars cannot be prevailed upon to repeat the entertainment.

Another Fatal Accident.—Last Saturday's *Evening Standard* states that considerable sensation has been created in an American town by the accidental death of one man and the severe injuring of another from an electric shock. The two victims, both Italians, were standing together at the corner of a street, one of them leaning against an electric light pole. There was a flash of electricity, and instantaneously the man whose back was in contact with the pole dropped down dead at the feet of his companion. The latter stooped to pick up the dead man, but, as soon as his hand touched the body, he received a shock powerful enough to throw him to the ground, where he remained insensible until assistance came. On his recovery it was found that the hand that had been brought into contact with the body of his deceased friend was quite burned to a crisp, the injuries necessitating the immediate amputation of that member. Investigation showed that the man who lost his life had leaned against a hoisting wire running along the pole from the main wire to the ground; and his body becoming entangled in it, when he fell, the shock was communicated to his companion who stooped to raise him. The wire which brought about the double calamity was being strung throughout the town, and no current, says the American papers which relate the accident, had been turned on, there being no circuit. It is conjectured, therefore, that it was crossed by the wire of another company, and that in this way the current was produced.

The Transport of Accumulators.—It appears that in many instances accumulators, when sent to any distance, sustain more or less damage in transit. Cannot some safe method be devised and adopted in order to save complaints on this score? Or is damage during transport a term merely used to hide indifferent construction and workmanship?

Dynamo-Electric Machines.—The letter which we publish this week from the pen of Sir David Salomons is of an eminently practical nature. He appears to have hit the right nail on the head respecting the "economy per pound of copper." Certainly nobody would think of using incandescent lamps which are highly economical in electrical energy per candle-power, if their lives were not sufficiently long to justify their employment. Such facts as those contained in the communication to which we refer are of the greatest value, coming as they do from one who cannot possibly have any preference for any one manufacturer rather than another, except for the quality of his wares.

The Efficiency of Electro-motors.—Speaking of the performances of electro-motors, Mr. Mordey, in his paper on "The dynamo as a generator and as a motor," says:—"With electro-motors, on the other hand, one has to be contented with a much lower efficiency. The energy supplied to them is severely taxed in the process of conversion. Motors frequently yield, as mechanical energy in a useful and available form, only 30 per cent., and seldom more than 60 per cent. of the electric energy absorbed." Mr. Mordey is probably not aware that Mr. Reckenzaun's motors of ½ horse-power give an available return of 55 per cent.; one to two horse-power motors, 60 to 70 per cent., and larger ones 75 per cent.

Foreign Competition.—A capital leading article appeared in the *Daily Telegraph* of the 14th inst., on the depression of trade in England, and the increasing foreign competition with which we have to contend. The writer clearly established the fact that it is upon our own shoulders that the blame must be laid for such a state of affairs. As an instance of what can be produced abroad, we were shown last week, by a gentleman well known in the electrical profession, a trembling bell of the Rédon system, which could be sold here in quantities at a less price than our manufacturers could possibly produce it. The article was elegant and pleasing in appearance, well made, and ridiculously low in cost. If small articles can be manufactured on the Continent and sold in England at less than the cost of construction here, why not larger electrical goods? We also note that a well-accredited rumour comes from the other side of the Atlantic, that it is the intention of some wealthy and patriotic Americans to engage the premises at Philadelphia which have been occupied for many years by the celebrated John Roach, and to devote them to the uses of a joint-stock shipbuilding company. The projectors of this enterprise consider that the time is at hand when it will be possible to build iron ships of the highest class and largest size as cheaply and efficiently on the eastern seaboard of the United States as upon the Thames, the Clyde, the Tyne, the Mersey, the Tees, the Wear, or the Humber. At the present moment it is alleged that labour is but ten per cent. higher in Philadelphia than in this country; while, according to Mr. John Roach, "ten American artisans are equal to at least fourteen or fifteen Englishmen of the same class." He adds that skilled hands in the United States work quicker, more intelligently, and for more hours in the day, and, if necessary, in the night, than any of their congeners in the "Old Country." So that the best results will, in his opinion, follow from the establishment of a joint-stock company for building ships of the highest class. "Our iron and steel," says this veteran employer of labour, "are far better than those produced in England; we have coal to an unlimited extent and at the cheapest rates; and all that we want is skilled supervision."

Electric Alarms in Railway Carriages.—In response to enquiries, provoked by the recent murder of a Prefect in a railway carriage near Paris, the French Minister of Public Works stated that the railway companies had been repeatedly pressed to take precautions for greater security in railway travelling, and all but the Orleans Company had now electric alarms. M. Delattré urged the futility of the electric alarms if sleeping passengers were attacked; and he quoted a colleague's remark that, had a Minister been murdered instead of a Prefect, the compartment system would be at an end in six months.

The Edison Telephone Patents in Canada.—We understand that in an action brought by the Telephone Manufacturing Company of Toronto against the Bell Telephone Company of Canada to set aside the three patents granted to Mr. T. A. Edison in Canada, for alleged forfeiture on the grounds of *non-manufacturing* and *importing* in the terms of section 28 of the Canadian Patent Act, the Minister of Agriculture has decided in favour of the Bell Company and upheld the patents.

A Warning.—A fellow, giving the name of Watson, is prowling about amongst engineers' offices, at which he calls to inform the occupier thereof that the Deputy-Manager of the Albert Docks Railway Company, whose correct name he gives, wishes to see him the next morning on professional business. Before leaving he makes some pretext to ask for money which, in some instances, he may receive. We need scarcely say that the company knows nothing whatever of the man, so if he should favour any of our readers with a call they would act wisely in detaining him for enquiries into his antecedents.

Power Required for the Elevated Railways.—Mr. Frank J. Sprague makes the following communication to the New York *Electrician and Electrical Engineer*: "'It would be very difficult for an outsider, not an electrician, to form any idea of the feasibility or probable economy of propelling the elevated railroad trains by electricity, unless he had given that subject and particular problem a great deal of attention and calculation.' I quote the above from an article in the March number of the *Electrician and Electrical Engineer*, by Charles G. Curtis. It is not my intention to enter into any discussion of this article generally. I should be inclined to make no reference to it nor to the 'corrected figures' appearing in the May issue, had Mr. Curtis let bad enough alone and not plumed himself on his accuracy by reference in the November number to Mr. Sinclair's valuable experiments. It is time that his manifold errors on work done by the elevated road engines were pointed out. The first article represents the engine as having nothing to do but ordinary traction at a mean speed of 12·5 miles per hour, gives a mean power of 23 horses, and a net consumption of 19 lbs. of coal per horse-power hour. The next article corrects this by taking into account the work expended in raising the train to its full speed, increases the engine power to 75 horses, and reduces the expenditure to 6·6 lbs. of coal per horse-power hour. In Mr. Curtis's last letter he 'refers to it (Sinclair's work) because it is so satisfactory a verification of the results arrived at by a theoretical mechanical calculation,' &c. Allow me to present a few facts for Mr. Curtis's consideration. The work done on the elevated roads is expended in three, not two, ways; overcoming the inertia of the train, lifting it bodily from the level of low to that of higher grades, and traction. The proportions of work are very nearly as follows:—Overcoming inertia, 59 per cent.; lifting, 24 per cent.; traction, 17 per cent. Mr. Curtis lost sight of the grades of this road, which require that a train be lifted bodily an aggregate of 282 feet in one round trip. The work so done is half as much again that expended in traction. The average net horse-power distributed over the entire time of a trip is about 69 H.P. The actual engine capacity is about 185 H.P. per minute. The mean running speed between stations is 14·7 miles. Mr. Curtis's agreement with Mr. Sinclair is purely accidental, caused by getting his average maximum speed too high, leaving out the work of lifting, about a quarter of the whole, and the element of engine or motor friction. Some papers will be made public in a few days which will give the methods of getting the above results, and also answering some of Mr. Curtis's queries, why and how shall the elevated roads be operated by electricity? One of those answers is that the capacity of the roads must be increased independent of the saving in coal expense, although this is perfectly practicable. 'I, for one electrician,' and one whose faith in the future of electric propulsion is not so easily shaken, will be glad to soon show Mr. Curtis how this is to be done."

Overhead Wires and Snowstorms.—The following letter has been received by a gentleman who pointed out to the Postmaster-General that serious loss is incurred by the commercial community through the breakdown of telegraph wires by snowstorms, &c., and inquired whether the department contemplated an established system of underground wires, similar to those now in use in the German Empire:—"General Post Office, London, January 15th. Sir,—I am directed by the Postmaster-General to acknowledge the receipt of your letter of the 12th inst., and to inform you in reply that this department has already placed a very large number of wires underground in and around London and in and around the principal towns in the United Kingdom. More works of this kind will be carried out from time to time as opportunity offers, but the Postmaster-General cannot hold out a hope that the telegraph wires throughout the country will be placed underground.—I am, Sir, your obedient servant, C. H. PATEY."

The Dynamo Tests at Philadelphia.—Speaking of these tests, to which we have several times alluded, and respecting which we published the report of the committee of the Franklin Institute on November 21st, 1885, and subsequently, the American *Electrician and Electrical Engineer* says:—"The character and ability of the gentlemen composing the committee are such, and the facilities at their command have been so unusual, that the results, as a whole, may be regarded as of greater practical value than any which have hitherto been rendered accessible to the public."

Motor-Armatures without Iron!—M. Hospitalier, in commenting upon the paper of Mr. Mordey, published in our issue of the 8th inst., concludes thus:—Does it not result from the interesting study made by Mr. Mordey, that it would be possible to make motors without iron in the armature, as they make the generators such as Siemens, Ferranti, Bollmann, &c. The cause of loss pointed out by Messrs. Mordey & Watson would thus be removed, and we should be placed in the theoretical conditions, indicated at the beginning, of an intense magnetic field acting upon conductors traversed by a current. We should be glad to know the results of experiments made in this direction.

Electric Locomotion.—This subject is now attracting some attention in the United States, and in the January issue of the New York *Electrician and Electrical Engineer* Mr. Frank C. Lockwood has an article pointing out the dangers to which travellers on the cable trams which cross the East River Bridge are subject, and the advantages of an electric system of propulsion.

The British Association.—The meeting of the British Association to be held at Birmingham, beginning on Wednesday, September 1st, will derive more than usual interest and importance from the exhibition of local manufactures which is to be held in connection with it. The Association has met three times previously in Birmingham, in 1838, 1849, and 1865. On each occasion an exhibition of local manufactures was held, and it is an interesting fact to record that to the example of the first of these are due all international and other exhibitions since conducted on so large a scale. The exhibition of 1838 was the first industrial exhibition in the country. The Prince Consort visited the one in 1849, and it suggested to him the idea of the International Exhibition of 1851. The exhibition which is to be held on the forthcoming occasion will be on a very much larger scale and of a much more popular and attractive character than has ever been attempted before. It is to be an exhibition illustrative of products and processes connected with the manufacturing industries of Birmingham and the surrounding district within a radius of 15 miles, which will include the whole of the Black Country, the nail district, and other towns where manufactures are carried on. The exhibition will be on a very complete scale, and will embrace as nearly as possible all the industries of the district, which will include the following:—Engineering, hardware, heating and lighting, arms and ammunition, jewelry, glass and pottery, stationery, leather, furniture and decoration, and a miscellaneous class, including scientific and musical instruments. The special feature of the undertaking will be that in every trade represented processes will be either completely shown or fully indicated. Workmen will be seen engaged in carrying out most interesting or difficult operations connected with various industries. The exhibition will be opened on August 26th, and close on October 1st, three weeks after the termination of the visit of the Association. Arrangements are being made with the railway companies to facilitate the arrival and departure of excursionists. High-class musical entertainments will be provided, and the best known bands in London will be engaged. Excursions to places of interest will be arranged.

Some Electrical Work in 1885.—During the past year, Messrs. J. D. F. Andrews & Co. have completed a large number of installations, of some of which descriptions have already appeared in our columns. Amongst others we may mention the following:—The Cunard Steamship Company's *Umbria* and *Etruria*, 850 glow lamps and two arc lamps each; H.M.S. *Ajax*, 290 glow lamps; H.M.S. *Conqueror*, 160 glow lamps; ss. *Corangamite* and *Burrambeet*, belonging to Messrs, Huddant, Parker & Co., of Melbourne, 160 lights each; Captain Parker's steam yacht *Lady Beatrice*, 35 lights; Messrs. R. & J. Dick's boot shop, High Holborn, London, 70 lights; Messrs. Simons & Co.'s dredger *Melbourne*, 6 arc lamps, &c., &c.

It may be of interest to those who have read our descriptions of some of these installations, to learn that they are giving entire satisfaction, and that they have not given the slightest trouble since they were completed. The firm had its apparatus on exhibition for the first time at the International Inventions Exhibition. It has during the year supplied a number of Andrews dynamos and other apparatus through agents and on its own installations, and during the last few months has largely increased the facilities for turning out these machines quickly, in order to keep pace with the increasing demand. The firm has also recently made some very material improvements in the Andrews arc lamp, and has obtained some excellent results from the trials that have been made.

The company has booked some pretty considerable orders during the last months of the year, amongst which we may mention Messrs. Geo. Smith & Son's ss. *City of Bombay*, which it has just lighted with 110 lights and a duplicate set of machinery; a block of mills at Lancaster, amounting in all to about 500 lights, the lighting of three large passenger steamers for the North German Lloyd, with about 450 lights each, an installation of arc lamps in Mr. Houghton's steel works at Carnforth, another arc installation in a paper mill at Leslie, &c., &c. The company has also a number of orders for the Andrews dynamos and arc lamps, and has every prospect of more business in the year upon which we are just entering than in the past year.

Transmission Dynamometers.—We publish in another column a letter from Mr. C. F. Heinrichs, in which he gives his reasons for doubting the accuracy of the recent dynamo tests in Philadelphia. We think it highly probable that there is some truth in Mr. Heinrichs's criticisms.

Electric Fire Alarms.—At a recent meeting of the Glasgow Town Council it was mentioned that the street fire alarms had been the means of conveying 163 alarms of fire, and only failed on three occasions to transmit an alarm when required. As the new alarms were nearly completed, Mr. Paterson was sanguine that the number of false alarms will be diminished, and that they will prove more reliable than the old ones.

Electric Lighting at Taunton.—On Monday evening, last week, Mr. C. J. Wharton, of the firm of Laing, Wharton and Down, electric light engineers, Holborn Viaduct, who are the suppliers of the light with which the main street of Taunton and some of its principal business houses have been served during the past month, delivered a lecture in the Victoria Rooms on "Electric Lighting." The interest manifested in the subject was proved by the large attendance, the hall being crowded, and the Mayor, Mr. T. Penny, presiding. Mr. Wharton in the course of his lecture said that there were at that moment about 100 companies in the States using the Thomson-Houston system, and most of them were making a profit of 10 or 12 per cent., the lowest being 8 per cent. On the 1st October, 1883, there were 1,653 Thomson-Houston lamps in the various cities, and on the 1st October, 1885, there were 16,475. The local companies had gone up from 22 to 102. In most instances the old companies had trebled the number of lamps with which they originally started, and that increase of business was a much healthier sign than the increase in the number of companies. The Thomson-Houston lamps exhibited at the Inventories gained the gold medal in spite of the strong opposition of other companies, the most formidable of which—the Brush—was awarded the bronze medal. Having done that his firm started to push the system in this country, but he regretted to say business was very slack indeed. There was no such enterprise as the Americans possessed. The Americans were not rush-ahead people, they were on the other hand very 'cute, calculating people; but they went thoroughly into a matter, and if they saw a chance of making it pay they adopted it. He, the lecturer, was doing better business on the Continent than in England. When he introduced the Thomson-Houston system on this side of the channel, he arranged for the plant to be supplied at 25 per cent. less than was obtained for it in America and on the Continent, and notwithstanding that he had not secured an order from any town in England.

As the result of a month's trial of the Thomson-Houston system, the principal tradesmen of Taunton have held a public meeting, for the purpose of considering the desirability of retaining the light in permanence for public and domestic use, by establishing a limited liability company to supply it. Mr. Massingham, of Bath, Taunton, and Torquay, to whose efforts the introduction of the electric light in Taunton is mainly due, explained its cost. He said each arc light on an average would cost £15 a year. The capital required he estimated at about £5,000, which would be sufficient to erect machinery to supply 120 arc lights; £3,000 had already been found. A resolution in favour of adopting the light was unanimously carried.

Earth Currents.—At the ordinary meeting of the Royal Society, Edinburgh, held on Monday night, Prof. Chrystal read a paper by Mr. H. N. Dickson, on Earth Currents in the Ben Nevis Observatory Telegraph Cable. On account of the frequent disturbance of telegraphic instruments at the observatory by earth currents, the inference was drawn that these currents always existed with more or less strength, and a series of observations, extending from the middle of September to the middle of October, 1885, was taken to determine, if possible, how far these disturbances were regular. Observations were taken hourly by means of a galvanometer inserted in the telegraphic circuit, from which it appeared that from midnight till 4 a.m. there was an earth current passing up the hill, and reaching its first maximum about 2 a.m. There was then a slight return current down the line till about five. At that time a strong current up the line set in, reaching the maximum for the day at 10 a.m., and its minimum at 1 p.m. After that the current increased pretty rapidly down the line again till 3 p.m., when it was rather unsteady till 8 p.m. An uphill current set in again steadily, increasing till 9, and reaching a minimum at 11. During the time when these observations were taken the summit of Ben Nevis was almost continuously enveloped in storm and mist, which necessarily affected the result. It was observed that when the top of Ben Nevis was clear there was a strong current coming up the line. Otherwise the current was reversed. During a fall of snow the current was observed to be down the line. Professor Chrystal said these results opened up an interesting field in electrical science which could only be thoroughly investigated by help from Government. One thing required would be to obtain possession of a land line to make experiments as to the effect of earth currents along the horizontal.

Electric Lighting on Yachts.—Mr. John Clark, of the Anchor Mills, Paisley, left Largs, on Monday evening, in his steam yacht *Mohican*, for a three months' cruise in the Mediterranean. The *Mohican*, which is the only steam yacht from the Clyde that will winter in the Mediterranean this year, has been fitted with the electric light in all her cabins, and in the officers' and crews' quarters, the total number of lamps being 78, besides which there is a large "search lamp" fitted on deck.

The Reis Telephone.—Our readers will peruse with pleasure the opinions, which we publish this week, of eminent American scientists upon the invention of Phillip Reis.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES

Northern District Telephone Company, Limited.—The annual return of this company, made up to the 4th inst., was filed on the 12th inst. The nominal capital is £100,000 divided into 15,000 ordinary shares of £5 each and 2,500 preference shares of £10 each. 2,076 preference shares have been taken up, the calls received thereupon amounting to £17,810 16s. 4d., leaving £324 3s. 8d. unpaid. As compared with the previous return, the paid-up capital shows an increase of £7,247 16s. 4d.

W. T. Henley's Electric Light and Power Company, Limited.—The annual return of this company, made up to the 4th inst., was filed on the 12th inst. The nominal capital is £100,000 in £1 shares. 6,868 shares have been taken up and the full amount has been called thereon. The calls paid amount to £6,828, leaving £40 unpaid. The sum of £41 10s. 11d. has been paid upon 101 shares forfeited. As compared with the previous return, the paid-up capital has been increased by £3,821.

United Telephone Company of the River Plate, Limited.—The annual return of this company, made up to the 11th inst., was filed on the 15th inst. The nominal capital is £200,000 in £5 shares. 20,397 shares have been taken up and the full amount has been called thereon, the calls paid amounting to £101,980; the paid-up capital thus exceeding by £700 the amount recorded as paid up in the previous return.

William Elmore, Limited.—The annual return of this company, made up to the 31st ult., was filed on the 13th inst. The nominal capital is £240,000 divided into 16,000 A and 8,000 B shares of £10 each; 3,909 A and the whole of the B shares have been taken up and the full amount has been called thereon. The calls received amount to £38,160, leaving £930 unpaid, and £80,000 is considered as paid upon the B shares. As compared with the previous return there is an increase of £72,705 in the paid-up capital.

Continental Etevè Engine Company, Limited.—The registered office of this company is situate at 15, New Broad Street.

CITY NOTES, REPORTS, MEETINGS, &c.

Maxim Weston Electric Company, Limited.

An extraordinary general meeting of this company was held last Friday at the City Terminus Hotel, Cannon Street, to consider two resolutions for reducing the capital of the company. Mr. Hugh Watt, M.P., presided. The Chairman in moving the first resolution, which was for reducing the capital by £62,500 by cancelling paid-up capital unrepresented by available assets (being patents over-estimated in value) to the extent of 5s. a share on each of the 250,000 shares issued, referred at some length to the past history of the company, and went on to to say that in purchasing the Maxim and Weston patents the company had been able to carry on a legitimate business; but, having paid between £50,000 and £60,000 for them, he thought that provision ought to have been made by which the company could obtain in the future plant from the United States Company at a much less cost than ordinary purchasers. He was glad to state that the management of that company in America had met him so far in a very handsome way, on the representations which he had made to them. On the working of the past 21 months they showed a handsome profit, and for the past year they would show, when the accounts were presented, a good profit, enabling them to declare a dividend in the event of the proposed resolutions being agreed to. During the past year the working purposes of the company had necessitated the issue of 50,000 shares, which the proprietors sanctioned in May, 1884. That capital had been placed, the limit given to the directors being 5s. a share. There was consequently a large deficit, and he was advised by their solicitor and counsel that it would be impossible to declare a dividend until the capital had been reduced to the present price of issue. Two years and nine months ago they sanctioned the issue of 27,500 shares at 5s., and the old shareholders thought that was no inducement to them even to save their property. He had been very much pressed during the last year by shareholders who desired a dividend, and if the directors could have declared one without "cutting" the capital he would not have troubled the shareholders that day. It had, however, been decided by the High Court of Justice that a dividend could not be declared unless the capital were intact. The shareholders had twice sanctioned the issue of shares at 5s. each. Of course, the directors would not have issued that capital had it been possible for them to go on without it, but all the working capital they had, after paying the debts of the old company, was £2,500. Some of the old original patents had expired, and therefore, during the past year, while they had done considerably more business than in the previous year, they had probably not made a larger profit, as they had had to meet the market in price. The directors did not wish to press the resolutions if the shareholders did not desire a dividend; but, after all, the reduction of capital would be effected by writing down the patents account. It would therefore not affect the intrinsic value of their property, though he did not say it would not affect its market price.

Mr. Swabey (a director), in seconding the resolution, observed that if he could have his way he would go further than was now proposed. He would not only reduce the shares to 5s., but would afterwards convert them again into £1 shares by exchanging four shares of 5s. for one share of £1.

Mr. Thomas objected to the resolution. In March, 1884, he said, they wrote off for depreciation of the patents £43,967.

Mr. Griffith said he altogether took exception to the law as laid down, that dividends could not be paid in existing circumstances; but apart from that there were other objections to the resolution. The shares had already been written down to 10s. from £1.

Mr. Russell proposed an amendment postponing the consideration of the matter until the accounts for the year had been presented.

The Chairman, in reply, said he was satisfied, having examined the judgments which had been delivered, that a dividend could not be declared in the present position of the company without personal liability attaching to the directors (a view subsequently endorsed by Mr. John Newton). On the 31st December last the company had about £12,000 at the bank, some £12,000 was owing to them—about one-third being due from the British or Colonial Governments—and they owed about £300 or £400. In reply to further questions, he stated that they had greatly improved on the Maxim and Weston patents. If the resolution were not passed it would virtually mean no dividend for two years. There was no power at present to issue any more shares, but possibly at the general meeting he might ask them to authorise the directors to issue, as and when required, a further 50,000 shares. If so, however, it would be in connection with a matter which would place the company on a very different footing.

Ultimately the amendment was withdrawn, and the resolution was then passed.

The Chairman then moved, and Mr. John Brown seconded, a resolution which was afterwards passed, further reducing the capital by £62,500 by reducing the nominal amount of the remaining 250,000 shares from 10s. to 5s., "thereby leaving the nominal capital of the company £125,000, divided into 500,000 shares of 5s. each."

This terminated the proceedings.

German Union Telegraph Company, Limited.—Payment was made on the 8th inst. of the dividend of 16s. 6d. per share (coupon No. 4) on the 5½ per cent. original preference shares of £15, or 300 marks each, at the office of the London Agency, Winchester House, 50, Old Broad Street, E.C. Payment was also made of a dividend of 12 marks, or 11s. 9d. per share (coupon No. 5) on the original shares of 100 thalers, or £15 each.

Globe Telegraph and Trust Company, Limited.—The payment is announced of an interim dividend on and after the 18th inst. of 3s. per share on the preference shares, less income-tax, and of 1s. 6d. per share on the ordinary shares, free of income-tax, for the quarter ending 18th January next.

Western Union Telegraph Company, Limited.—Messrs. Morton, Rose and Co. announce the numbers of the Six per Cent. Sterling Loan of this company, drawn for payment on March 1st.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending January 15th were £2,429, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

The West India and Panama Telegraph Company, Limited. The estimated receipts for the half-month ended the 15th January are £2,685, as compared with £2,624 in the corresponding period of 1885.

The Brazilian Submarine Telegraph Company, Limited. The receipts for the week ended January 15th were £3,147.

NEW PATENTS—1886.

523. "Automatic electric fire alarms." J. W. SMITH. Dated January 13.

532. "Machine for increasing the utility of the telephone and telegraph to the general public." G. J. RHODES. Dated January 13.

584. "Telephone apparatus." S. A. EDWARDS. Dated January 14.

611. "Secondary voltaic battery." O. IMRAY. (Communicated by A. Khotinsky.) Dated January 14.

615. "Dynamo-electric machines." W. GRIERSON. Dated January 14.

621. "Galvanic batteries." F. H. VARLEY, VARLEY ELECTRIC PATENTS PROPRIETORY. Dated January 14.

639. "Erecting overhead telegraphic, telephonic and similar wires." J. POOLE, K. MACIVER. Dated January 15.

654. "Apparatus for electric lamps." H. DEFTY. Dated January 15.

668. "Electric telegraph receiving instruments." F. H. W. HIGGINS. Dated January 15.

723. "Electro field-magnets for dynamo-electric machines, &c." R. KENNEDY. Dated January 16.

741. "Arc electric lamps." T. STANLEY, A. H. DAVIES, C. RICHARDSON. Dated January 18.

769. "Arc lamps." J. H. HOLMES. Dated January 18.

771. "Generating or utilising electricity." H. EDMUNDS, W. T. GOOLDEN. Dated January 18.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1885.

800. "Improvements in the treatment of sulphides in alkaline solutions by electrolysis." H. W. DEACON, F. HURTER, and W. ELMORE. Dated January 20. 6d. Consists in passing through solutions containing alkaline sulphides a current of electricity so that the sulphides contained in the said solutions may be decomposed by the current in such manner either that the sulphur is deposited upon the anode, hydrogen being evolved at the kathode, or that a portion or practically all of the sulphur is oxidised at the anode, hydrogen being evolved at the kathode.

1088. "Improvements in galvanic or primary batteries." C. M. NEWTON. Dated January 26. 8d. The negative pole of the battery is constituted by a metal capable of being attacked by the exciting fluid or liquid of the pile or battery when the circuit is closed, for example, zinc, tin, lead, copper, or any metal of like nature and properties. The positive pole is formed by a plate or plates of iron, copper, lead, or other metal, which are allowed to dip into, or are placed in contact with, a quantity of oxide of lead or litharge, or else it is formed by the containing vessel or cell being made of wrought or cast iron (or copper, lead, or other metal), and a quantity of oxide of lead or litharge at the bottom and sides as a depolariser.

1183. "Improvements in mechanical telegraphs and indicators suitable for use on ship board, and in other places." H. BOTTEN. Dated January 27. 8d. The improved telegraph and indicator is adapted to transmit a limited number of definite orders and the acknowledgments of or replies to such orders; such communication, in short, as it is necessary to carry on between the bridge of a steamer and the engine room.

1234. "Improvements in electrical signalling and recording apparatus, applicable for use on railways." J. ENRIGHT. Dated January 28. 8d. The objects in view are the transmission to railway trains of the signals necessary to regulate their movements, and to ensure a record of such signals; an especial feature of the present invention being that the stop or "danger" signal shall be given to the train by disconnecting the station battery from the line wire whilst the safety signal is given by the passage of the current in the line wire.

1764. "Improvements in secondary batteries." J. S. SELLON. Dated February 9. 8d. The inventor arranges the plates so that the elements or plates of one pole may be transverse to the elements or plates of the other pole.

1853. "Improvements in dynamo-electric machines." T. NORDENFELT. (Communicated from abroad by O. F. Jönsson, of Stockholm.) Dated February 10. 8d. Has for its object the transformation into electricity of as much as possible of the mechanical work consumed on the machine shaft, the arrangement being such that the production of extra currents, sparks, and friction in the bearings and contact brushes are obviated as much as possible. Besides the improved effect, the further advantage is attained that the iron masses of the machine working as magnets are not heated by so-called Foucault's currents.

13279. "Improvements in insulators for telegraph wires and the like." W. P. THOMPSON. (Communicated from abroad by E. A. Müller, of Germany.) Dated November 3. 6d. As shown in Figures 1. and 2, the insulator has a perpendicular slit, *s*, cut into it from above, dividing its head into two segments; each of these segments has a piece cut out of it horizontally, somewhat deeper than to its centre, and these two horizontal cuts are in opposite directions, each segment consequently assumes the shape of a hook, one turned in one direction, and the other in the other, as shown in the drawings at *l* and *r*. In order to secure the telegraph line *a*, *b*, in the insulator, the line is inserted in the vertical slit, *s*, and the insulator is rotated a quarter turn towards the left, whereon the hooks *l* and *r* clasp the line.

FIG. 1.

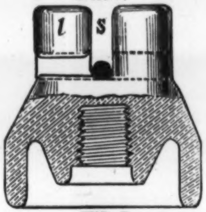
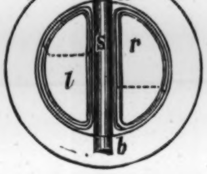


FIG. 2



CORRESPONDENCE.

Dynamos and Domestic Electric Lighting.

Electrical facts from impartial observers are the most valuable, if truthfully recorded. Having used my best endeavours to obtain reliable results, and standing on neutral ground, the following may be acceptable for publication. My object is not to *puff* any particular maker, but to indicate the lines on which future improvement should advance. Many Siemens machines have passed through my hands, and the last was made the end of 1884. Although these machines gave good results when worked near their maximum, their efficiency was very bad when small currents were taken off. This firm has "marched with the times," and I therefore give the date to avoid being unfair. Crompton's machines have a good efficiency, but I have had endless trouble with the bearings and brushes, due to the great length of the bearings and high speed. The difficulty of oiling long bearings is very great, and if the speed gets the better of the oil for a moment, it is all over, and the bearing gets very warm, and consequently the commutator also. Thus constant watch must be kept on these dynamos, and even then they are troublesome. The work is excellent otherwise. Mr. Crompton, recognising these difficulties, has been good enough to improve and exchange my machines, and I have little doubt that the difficulty here mentioned will disappear. I consider that unless a dynamo may be left without anxiety for five or six hours it is not a practical machine, and no possible harm should occur by being left to itself for 10 or 12 hours. Elwell-Parker's machines have also failed in my requirements till quite recently. This firm has built several dynamos for me, and at last a machine has been produced such that a better one cannot be wished for. The requirements of the machine were all specified by me, and Messrs. Elwell-Parker had to build a special size (not in their list) to meet the case.

The reason for success is greatly due to total disregard for "economy per pound of copper, &c.," which is, to my mind, great nonsense, because, to compare such results with a steam engine, it would mean that makers would struggle with one another to turn out an engine to do a certain work with the least possible quantity of metal in it, and thus the slightest extra strain would cause a breakdown. This is what dynamo manufacturers are aiming at now, and the public imagine that "economy per pound of copper" means something very good. It really means most profit in the manufacturer's pocket, for I do not find that such machines are sold cheaper in comparison with others. Considering the expense of dynamos, £5 more or less is a small matter in the cost, but a large item in its lasting powers. Let me ask, Why do the "Pound wise" people go to the best engine makers and pay about double for an engine of a certain nominal H.P., which might have been bought for the half from some other firm? It is because they are better made, less easily strained, and more lasting. Yet the same "Pound wise" do not see things in the same light when it comes to a dynamo. It is the "per pound of copper efficiency" which blinds them. They do not say "per pound of iron and steam efficiency" in a steam engine. These remarks may appear hard but they are true enough. I must not be misunderstood to mean that the more copper the better the dynamo. I mean that in a good and well designed dynamo the weight of copper should be quite a secondary thing; efficiency comes first; first cost and weight are small matters compared with daily waste of coal and oil. For tramcar work, of course, weight is an important factor, but I am not treating of these machines. Now to describe the last machine supplied to me by Messrs. Elwell-Parker. It is vertical and would be called about a 30 unit size. Armature, 16 inches diameter, by 24 inches long. It is a 4-pole machine, 5 feet 9 inches high. At 400 revolutions 100 ampères may be taken at 130 volts (I have not yet tried larger currents from it). The machine will give 250 ampères, and may be run up to 800 revolutions per minute, so that its capabilities are very great. For my special purposes resistances are put into the F.M. circuit (being simple shunt), and I find not the *trace* of sparking, no matter what current is being taken off, or what resistance is put in. For experiments, resistances were inserted reducing the 130 volts down to 10 or 12 volts, and yet no sparking occurred. The field-magnet coils are as cool after 12 hours' run as at the start, no perceptible rise in temperature. About 3 to 4 ampères pass these coils in practice. The commutator is greased at starting, and not touched all day. The brushes only just bear on the commutator, and do not press heavily. By the construction of the machine, the ventilation is very good, and four pole machines are peculiarly adapted to this end. The bearings are greased with cups of solid grease pressed down by a piston, and so excellent is the lubrication that the machine has run 201 hours 55 minutes for an amount of grease weighing perhaps $\frac{1}{2}$ oz. For since the last filling (over 200 running hours ago), the pistons have to the eye scarcely descended. Each bearing has two cups, holding about 1 oz. of grease in each, and they run *absolutely* cool. The dynamo weighs about 3 tons 6 cwt., and is remarkably steady when simply standing on the ground. Undoubtedly a large number of careful tests for efficiency have been made. The manufacturers place it at 95 per cent. My own experiments show 96 per cent. at best, and 90 per cent. at worst. By the latter I mean when only small currents are taken from it.

Result by comparison with other machines

After about 40 days' trial is as follows—two per cent. more E.M.F. and 10 per cent. more current were used, than with the other machines, and yet 20 per cent. less coal, thus my total saving is 32 per cent., say 30 per cent. This practical test is the best after all, for we use more lamp hours now, in the short days, run shorter time, and use far less coal. The dynamo is not well constructed for "economy per pound of copper," but what do I care when the saving is at least 14s. a week by its economy, or 2s. a day on average?

As was said at the start, it is not my object to advertise any particular firm, but to show what appears to me the proper development of dynamos in future. The points may be summed up:—

1. Slow speed.
2. Bearings not too long, and lubrication which shall not fail.
3. Plenty of copper to keep all parts cool.

No doubt many would like to know the cost of this dynamo. The price I am not at liberty to mention, because it was a special one, and far lower than could be made for general sale, which arose from the fact that the makers undertook to supply a machine at a price which was found impossible when experiments were made. I therefore must leave the publication of the list price to the manufacturers themselves, as I do not know it myself.

Let me incidentally add that the total cost of the installation here, as compared with gas, for 1885 has been four-fold; every possible charge having been allowed for, including sinking fund, but exclusive of interest. The installation has not been fairly used (through domestic events and electioneering) last year, that is to say, the average of lamps used nightly has been under 40 in an installation in duplicate for 400 to 500 lamps, or in all 1,000 lamps, so in reality the result is certainly good. If the nightly average of lamps had been about 100, gas would have been dearer than the electric light.

The importance of this communication must plead the apology for its length.

Before concluding I must pay a high tribute to Mr. Ferranti's current meter, which has shown many errors into which we had fallen, by estimating the current used over long periods by old methods.

David Salomons.

Broomhill, Tunbridge Wells,
January 18th, 1886.

American Telephone Patents.

Your editorial of October 31st, 1885, on American Telephone Patents, comes to this side in the midst of the most extensive presentation of facts on ex parte affidavits that has yet been made for the purpose of filing a Bill in the name of the United States, with the end in view of testing the validity of the Bell patent of 1876, on the ground of misrepresentation and fraud, whether legal or actual, or by acts of omission or commission on the part of the applicant or the Patent Office. Your criticism may be entirely just and proper as applied to the particular company at whose request the former suit was authorised by the Department of Justice, but in view of the public opinion existing in the United States, it will be very unwise and impolitic for the present administration to decline to commence the proceedings based on the ex parte evidence, unless such a proceeding be contrary to express warrant of law by a statute, decision, or general construction. You, of course, understand that the grievance and complaint on the part of the public in the United States as against the Bell monopoly is vastly different from that which the English public have had to contend with as the result of litigation on the English branch of the Bell patents. In the United States the *bête noir* of the Bell monopoly is the unwarranted extent and broad construction given by the inferior courts to the fifth claim of Bell's patent of 1876, of multiple telegraphy, as covering a broad claim to the method or process of reproducing articulate speech by electricity without regard to the form of the apparatus, namely transmitter or receiver. In view of the present knowledge of the actual and precise history of the state of the art at the time this broad claim was granted, it is a subject matter of wonderment and amazement that any man could pose before the world for nine years as the discoverer of a method or process of reproducing articulate speech without having such a preposterous broad claim passed upon and decided by the highest appellate court of justice in the land. Such a state of facts has only been possible in the United States, the owners of this patent knowing the inherent weakness of their position on the broad claim, by the enormous expenditure of money in the retention of the most expert and eminent lawyers in the land for the purpose of stifling an ultimate decision by delay or compromise in order to continue their oppressive monopoly. It is a fact beyond contradiction or cavil that at the present time, more than nine years have elapsed since the grant of the broad claim in the Bell patent of March 7th, 1876, and yet no case has been permitted to come before the Supreme Court of the United States for argument, and that the only case now upon the calendar of that court for argument is the Dolbear case, in which there is an admission of Bell's prior invention under the hope of establishing a distinction on the Dolbear receiver, known as the condenser. This case, coming as it does from Massachusetts, based upon such admissions and upon evidence taken in the then knowledge of the state of the art, is by no means such a case as should control the decision of the broad question in which the public in the United States is so deeply interested.

Without wishing to anticipate the action of the Secretary of the Interior on the facts and arguments which are now being presented to him on the various interests opposed to the Bell monopoly, it will readily be seen from the above how vastly important it is that such a suit should be authorized and instituted if there be any precedent therefor, so that a full presentation of all the facts and evidence in the control of the various opposing interests may be harmonised and crystallised into one proceeding, which, on account of its great public bearing shall have precedence of other cases, not only for the purpose of ending vexatious suits and litigation in all parts of the United States, but to settle at once and for ever the question as to whether the American Bell Telephone Company shall have the right to enrich a few men at the expense of the masses, and absolutely to prevent all competition and improvement in one of the greatest discoveries of any age.

Jerome Carty.

Philadelphia, *November 12th*, 1885.

[The dispatch of this letter from America must have been by some means greatly delayed. That the delay was not caused on this side is evident from the fact that the Philadelphia post mark is dated January, 1886. —EDS. ELEC. REV.]

Domestic Electric Lighting.

The following particulars of an installation I have just put to work to light the shop and show room of Messrs. Wm. Egan & Sons, jewellers, of this city, may be of interest, as they more than bear out the statements of Mr. J. H. Greenhill in your two last issues as to the work to be got out of the ½ H.P. Crossley gas engine. The installation at present consists of 25 Swan lamps, 20 and 10 candle-power; 26 E.P.S. cells, 17 S type, one modified Gramme armature dynamo, which I have designed and built specially for this installation, and a ½ H.P. Otto gas engine as motor. On the first night that the engine and dynamo were run (the accumulators were not used) it was found easy to light to their full incandescence 11 Swan 20 C.P. 52 volt lamps, and one 50 C.P. 50 volt (this latter being a little overworked), or equal to 13·5 of the 20 C.P. lamps. The consumption of gas was taken simultaneously, and was 54 feet per hour, from which it will be seen that Mr. Greenhill has rather under-stated the power to be obtained from an Otto ½-horse engine. The consumption of Cork gas is about 10 to 12 feet per hour more than of Belfast, but the light obtained is greater per unit of gas consumed by about 7 to 9 per cent.; this result is doubtless due to the high resistance of the shunt wire used to excite the field magnets of the dynamo, which are of wrought iron with laminated pole-pieces, and to the low resistance of the armature, whereby a considerable economy in the production of the current might reasonably be expected. But as Mr. Greenhill's dynamos are of as high efficiency as any in the market, it is probable that the saving is effected as much as anything in the transmission of the power from the engine to the dynamo, a matter about which electricians, especially in small installations, seem to trouble themselves but little, though it would repay attention quite as well as the most painstaking study of the best proportions for the electrical and magnetic portions of the dynamo, as with the high efficiency already obtained, four or five per cent. is all that could be realised in this direction! scarcely more than the difference arising from the use of good or bad lubricants. As the installation has been so successful, Mr. Egan is about extending the use of the light throughout his workshops and dwelling house with Messrs. Woodhouse and Rawson's lamps, on the completion of which extension I will send particulars of interest.

G. Percival.

Per pro ARTHUR PERCIVAL.

Cork, *January 18th*, 1886.

The Deprez Machines.

As I have not had opportunity of reading the ELECTRICAL REVIEW for a week or two, I am unable to know whether I have been forestalled in the observation I am about to make. With regard to the machines employed by M. Marcel Deprez in the extensive experiments now being carried on between Creil and Paris, I note a peculiarity of construction wholly at variance with what I conceive to be now generally accepted ideas. In each machine there are two rings or armatures influenced by multiple electro-magnets, which latter are arranged as horse-shoe magnets, *but with a pole acting upon each ring*. How, then, is the magnetic circuit completed? The brake or yoke connecting the magnet limbs is parallel to the shaft or axis of the rings; the magnetic circuits cannot, therefore, be completed through these yokes (apparently made specially heavy for this purpose), but through the side supports of the machine, by no means a direct course. I should be much obliged to any of your readers if he would point out my error, or suggest the principle aimed at, as I understand these machines to be models of constructive design, *par l'homme qui sait.*

Paget Higgs.

Re Electrical Formulæ.

TO MR. MOON,—I ask you for bread and you give me a stone. Instead of supporting by proofs or examples your former assertions as numbered in my last letter, 4, 5, 6, &c., you repeat them as bare and as false as they appeared in the first instance. As compensation you supply a fresh lot of similar matter.

The reason why I, nevertheless, address a few words to you is, that I should like in parting from you to show you that I am not, as you think, possessed of any bitter feelings on account of your just and friendly criticism.

I see now clearly that the misunderstanding, which for a moment has arisen between us, depends upon the fact that my formulæ and your criticism belong to two quite different worlds. In those regions from which you speak to me, I see from your last letter, that the velocity, being so different in the different dynamo armatures, is no more a mechanical condition, but might be used to express the electrical merit of the machines; *there*, according to you, *men of repute* rely upon weak fields in the dynamos; there a formula like

$$1 - \frac{\kappa_1 \, \mathrm{C} \, \mathrm{L}}{\mathrm{F} \, (\text{size of field}) \, \mathrm{V}}$$

is considered an improvement upon $1 - \frac{a \, \kappa}{\mathrm{F} \, \mathrm{V}}$ to express the same thing; there the term figure of merit would not be allowed in connection with dynamos on the ground that it is used to express the reciprocal of the current actuating a galvanometer, although the prophets use it always themselves when to the delight of mortals they treat of dynamo theories; there the sensibility of an electrical instrument is a thing widely different from its efficiency; and last, but not least, through the sublime wisdom which prevails there, it was decided that the expression "F × size of field" is the real formula for electrical merit (*sit venia verbo!*) which Mr. Andersen has been seeking but failed to discover.

Now, on the other side, in that prosaic practical world where I work, nearly everything is different; referring to the last point in the preceding, for instance, I should not like to see a 10 horse-power dynamo come out with a 10 times higher electrical merit simply because it is 10 times as large as a 1 H.P. one, nor in an analogous case the electrical merit of a galvanic cell to be expressed by the product of its electromotive force into the size of its plates.

But if thus, my dear sir, we work in different fields governed evidently by different laws, then, why should we fight any more?

F. V. Andersen.

January 18th, 1886.

[This controversy must now cease.—EDS. ELEC. REV.]

Magnetism.

Everyone who has attempted accurate physical investigation must concur with Mr. Smith in thinking that great caution is necessary in the manipulation of the apparatus and in the deductions from the observations.

Mr. Smith himself, in his recent articles on magnetism in your journal, has, I venture to think, fallen into some errors, which I should like to point out.

On page 33 it is said that it was found necessary to let the iron ring cool whilst revolving in a horizontal plane. This ring is afterwards found not to affect the magnet when its diameters are horizontal, but does so when they are vertical. No measurements are given. The following explanation accords better with the requirements of the case, and the theory of terrestrial magnetism:—Mr. Smith's method of treatment apparently converts the ring into an annulus of a magnetic shell, *i.e.*, with a fixed polarity on the sides, which is quite to be expected, for if whilst revolving horizontally the ring were to receive a blow so as to ensure polarity being defined, the underside will be north-seeking, and the top south. For, remembering that the "total force" at London is ·47 (dyne-units), and the value of H, the horizontal intensity, ·18, the practical effect of horizontal rotation is to eliminate H, but the ring is still in a field of force whose strength is equal to the vertical component and becomes magnetic in consequence. Let Mr. Smith, now, under similar circumstances, revolve the ring about a diameter in the three cases:—

I.—When the diameter is horizontal and east and west.

II.—When the diameter is horizontal and north and south.

III.—When the diameter is in line of magnetic dip and north and south.

The results in the three cases will, I think, be—I. No fixed magnetism, that is, as free from it as iron can be got. II. Magnetic showing poles at ends of the diameter about which the revolution took place. III. More strongly magnetic than II., with poles in the same relative position. A better and more conclusive experiment would be made with a sphere of iron similarly treated.

On page 48, Mr. Smith says—"On the other hand, if the magnets be placed *too close* to the iron, it will be found that they induce magnetism into the iron," &c. Perhaps Mr. Smith can tell us at what distance a magnet ceases to affect magnetic matter, and, what may be easier, what is the cause of the striking dis-similarity in the direction of the lines of force in diagrams 3 and 7 (fig. 1). In the former they appear to spring from the extremities, in the latter from some place situated less than a fifth of the magnet's length from the end.

In the apparatus shown in diagram 11 it would be interesting to know more of the commutating arrangements; whether it was found necessary to make any provision for eliminating retardation in coils H and K, and how freedom from induction from the other parts of the system was demonstrated.

With regard to the actual lengthening of a rod when magnetised, I can assure Mr. Smith that by means of a system of multiplying levers in connection with a mirror reflecting a beam of light, a deflection of the spot amounting to two feet is easily obtainable. The hypothesis that the distribution of the lines of force of the solenoid alters after saturation of the core is surely untenable. Why should it, and why did no one find an initial contraction instead of extension of the bar?

C. G. S.

The Analogies of Generators and Motors.

The valuable paper by Mr. Mordey you published in your issue of the 8th inst., to me, was very pleasing. Both Mr. Mordey and many of your readers will, no doubt, be interested on hearing of those analogies and laws he has lately demonstrated having been practically used. Nearly two years ago, having determined to use the Elwell-Parker dynamos as generators for transmitting power to drive underground pumps, and being at that time in search of a good motor for same, the questions arose: How should the motor be constructed to give the highest efficiency (its weight in this case being of little importance), and in what way should it differ from the generator? The matter was most carefully considered, and several experiments were made at the Trafalgar Collieries, Gloucestershire (where the machines were wanted), with the Schukert, Siemens and various Gramme dynamos as motors. By permission of Messrs. Elwell-Parker, at their works, I with Mr. Thos. Parker of that firm, further experimented on their machines. As we obtained a far higher efficiency than was expected, it led to a more careful investigation of the laws relating to the allied actions; during which, we clearly proved the analogies which Mr. Mordey now mentions. Moreover, the chief features which made that machine so efficient as a dynamo (viz., a very powerful field, with a comparatively small, low resistance, and highly magnetisable armature), we considered, and also practically proved to constitute its value as a motor.

Winding the armature with a single layer, thereby being enabled to attain a most intense field, and the greatest work for the minimum length of wire, *i.e.*, lowest resistance in armature—appeared to us to be as valuable in a motor, when driving a current through the field, as it is known to be when used in a dynamo.

Accordingly, the machines for the Trafalgar Colliery Company were built by Messrs. Elwell-Parker.

The motors had field magnets of a similar shape to their dynamo, and were compound-wound, keeping a constant field—by this means the engineman on surface can tell by his ammeter what work the pumps below are doing—the armatures had cores of soft iron wire, carefully insulated with varnish (the top layers being of a smaller wire), and wound with a single layer of copper wire. These machines were easily reversed—by reversing the current through the armature—not the slightest movement of the brushes being necessary, whether the full load was on or not. They were almost sparkless at the brushes, and have been working in the collieries ever since, running night and day, Sundays included; often working 22 hours out of 24, and are still at work, never even having had the commutators repaired.

I may mention that Messrs. Elwell-Parker (with whom I am now connected) have ever since then constructed their motors on those principles.

Those used at the Inventions Exhibition, and also those now on the Blackpool tramway, are so built, but in the latter case the field magnets are constructed of strips of wrought iron (Siemens type), being there limited for space and weight. Our experience is, that these machines, where properly handled, give most satisfactory results. We did not arrive at an accurate method of determining the power absorbed by eddy currents in the motor armature, and should, therefore, be much interested in any data Mr. Mordey or any of your readers could furnish on this important subject.

Carl T. Blanch Brain.

Wolverhampton, *January 19th*, 1886.

The Franklin Institute Tests of Dynamos.

I beg to enclose you a copy of a letter (contained in the *Electrical World*) which I addressed to the Franklin Institute. I was informed that the committee would take no further notice of my first letter. I should be glad if you would find it space in your valuable journal.

Charles F. Heinrichs.

233, Broadway, New York,
January 8th, 1886.

An Open Letter on the Franklin Institute Tests.

To the President and the Board of Managers of the Franklin Institute of the State of Pennsylvania.

Gentlemen,—I have pointed out in my letter to the *Electrical World* of the 19th ultimo, of which I forward you a copy, that the efficiencies given by your committee to the Edison and Weston dynamos are most probably too high.

The seriousness of this statement is too obvious to be passed over without due consideration. The public at large, the capitalist and the inventors individually, are interested to know the true efficiency of the dynamos tested by your committee.

A certificate of efficiency, as given in the report published by your authority, will be considered correct; but should it give an undue high efficiency to dynamos owned by the largest companies, it will be detrimental to further progress, and will prevent better systems being acknowledged.

Too many fictitious reports made by would-be experts have been given to the public during the last few years by unscrupulous promoters, and have drawn millions out of the confiding public, and there are at present corporations who are working (with their subscribers' money) the most unprofitable systems under worthless or expired patents; but are supported by fictitious statements of efficiency.

All this has produced the present distrust in any, even the most promising, practically proven and tested invention relating to electrical engineering. Hence, every testimony given by a scientific authority of your eminence ought to be jealously checked and compared with results previously obtained by other authorities, and any material differences found need well be explained.

I have shown, in my letter to the *Electrical World*, the great discrepancies between the horse-power measurements made by your committee and those obtained by other authorities; particularly the values of the horse-power absorbed by the friction of the armatures are given by your committee too small to be accepted at all.

When substituting a more probable figure for the latter items and then calculating the electrical efficiency of the dynamo, it will be found to amount to more than 100 per cent. Thus the conversion of the mechanical energy into electrical would have taken place, not only without loss, but actually with a gain, which is obviously impossible.

All measurements of the electrical energy given out by the dynamos tested by your committee must be accepted as correct, since the values of current, electromotive force and the resistance agree perfectly.

But it is to be regretted that your committee have not compared their horse-power measurements with other results obtained by a former committee appointed by your Institute. The following extracts of tests from Professors Houston and Thomson's tables are contained in the Journal of the Franklin Institute of 1878:

Name of dynamo tested.	Electrical energy in H.P.	* Approximate weight of armatures in pounds.	Number of revolutions of armature.	H.P. absorbed by friction of armature and resistance of air.
Brush ...	1·6	70	1,340	·54
„ ...	1·37	55	1,400	·45
Gramme ...	1·31	30	800	·137

* Taken from other notes.

Comparing the above values of the friction of the armatures with those obtained by Professor Adams and Messrs. Alabaster, Gatehouse & Co. (given in my letter to *The Electrical World*), it will be noted that they agree with each other and are proportionate; but the values found by your last committee agree with none of the former.

I shall now show that when substituting more probable figures for the items of armature friction the electrical efficiency of the dynamos tested by your committee will be more than 100 per cent.

Table I. of your committee report contains the data of tests of an Edison dynamo No. 5; the item for friction of the armature has been omitted; thus I may take the most probable figure. Prof. Adams found the friction of a much smaller Edison armature to absorb 1·55 horse-power. Accepting this figure, and calculating the electrical efficiency of the Edison dynamo No. 5, the following result will be obtained:

$$\frac{\text{Total electrical energy}}{(\text{Total power applied}) - (\text{power absorbed by friction of armature})}$$

$$= \frac{18{\cdot}23}{18{\cdot}89 - 1{\cdot}55} = 105{\cdot}5 \text{ per cent. (! !)}$$

Approximate calculations, made upon a basis given in my letter above referred to, show that the friction of the Edison armature No. 5 absorbs ·76 horse-power; though this figure may well be 300 per cent. too small for reasons explained; still, when accepting it, the following electrical efficiency will be obtained:

$$\frac{18{\cdot}23}{18{\cdot}89 - {\cdot}76} = 100{\cdot}5 \text{ per cent. (! !)}$$

Passing over to Table III. of your committee report, it contains the data of tests of a Weston dynamo No. 7. The friction of the armature is measured, to be from ·195 to ·311 horse-power, which can be rejected at the first glance. Prof. Adams found the friction of a Weston armature of one-third the capacity to absorb 1·337 horse-power. Accepting this figure, the following electrical efficiency will be obtained:

$$\frac{28{\cdot}47}{28{\cdot}29 - 1{\cdot}337} = 102 \text{ per cent. (! !)}$$

Taking, instead of Prof. Adams's figure, only ·82 horse-power as being spent on friction of that large armature, *the electrical efficiency would still be* 100 *per cent. (! !)*

Obviously these results are impossible, but show clearly that the whole horse-power measurements made by your committee are erroneous and too small, which explains the enhanced efficiency given to the Edison and Weston dynamos.

Trusting that the whole tests will be reconsidered by you and your committee, and when you have satisfied yourself of the improbability of the results, that the enhanced efficiencies given to the Edison and Weston dynamos be taken off the record,

I am, gentlemen, faithfully yours,

CHARLES F. HEINRICHS.

New York, *January 4th*, 1886.

[We have already commented upon Mr. Heinrichs's first communication which appeared in our columns on the 1st January. We know several well-informed engineers in this country who express grave doubts as to the accuracy of the results given by the Tatham dynamometer.—EDS. ELEC. REV.]

PATERSON & COOPER,
ELECTRIC LIGHT & POWER & TELEPHONE ENGINEERS
To H.M. Government, Leeds Corporation, &c.,
European Works, Pownall Road, DALSTON,
NEAR HAGGERSTON STATION.

Telegraphic Address:
"Patella, London."

Prize Medals.—Paris, 1881; London, 1882; Calcutta, 1883; London, 1885; Antwerp, 1885.

NOTICE OF REMOVAL.—On and after November 16th, 1885, our Offices and Show Rooms will be Removed to our Works at Pownall Road, Dalston, owing to Termination of Lease of our Premises, 76, Little Britain. (Our Works are close to Haggerston Station, and Ten Minutes from the City).

Dynamos.—Phœnix Dynamos for Incandescent or Arc Lighting, Ship Lighting, Plating, &c.

Search Lights for Naval and Military purposes; Submarine Arc Lamps for Salvage or Fishing.

Engines.—High Pressure and Condensing; Steam Boilers, Turbines, Water Wheels, Overshot Breast and Undershot, Shafting, Pulleys, Plummer Blocks, Gearing, Belting, &c.

Arc Lamps.—Licensees and Makers of Pilsen, Clarke-Bowman, Phœnix, "J. F.," and other lamps.

Accumulators.—Joel and other Secondary Batteries.

Telegraph Instruments.—Telephones, Switch-boards, Magnetos, S.N. Instruments, &c., &c.

Measuring Instruments.

Voltmeters.	Ammeters.
Cardew,	Electro-magnet,
Electro-magnet,	Ayrton & Perry,
Ayrton & Perry.	Joel-Paterson,
	Engine Room.

Incandescence Lamps.—Agents for Swan, Bernstein, Alexandra, Gresham and other well-known makes.

Carbons.—Hardtmuth's Soft Core and Wallace Diamond Brand.

Fittings.—Sockets, Holders, Lamp Reflectors, Switches (Maynard, "B. E.," Click Over, &c.), Safety Junctions. A large assortment of Brackets and Pendants suited for Mansions, Hotels, Corn Mills, Factories, Ships, &c.

Plating.—Nickel and Silver Plating done for the Trade; Complete Outfits of Plating Dynamos, Vats, &c., supplied to specification.

Secondary Generators.—Licensees for Gaulard and Gibbs system of Secondary Generators for Central Stations.

Exploders and Torpedo Gear.—Admiralty and Mackenzie Firing Keys; Fuse Exploders for Blasting.

Engineering and Electrical Work of all sorts carried out. Estimates and Specifications for Electric Lighting free of cost.

ELECTRIC LIGHT LEADS, GUTTA-PERCHA, INDIA-RUBBER COMPOUND BRAIDED COTTON, SILK-COVERED WIRES.

SPECIAL WIRES FOR DYNAMO MACHINES

PHILLIPS BROS.,
ELECTRICAL WIRE MANUFACTURERS,
THE LEA TELEGRAPH WORKS, HACKNEY WICK,
LONDON,
FORMERLY OF
MACINTOSH LANE, HOMERTON.

ESTABLISHED 1870.

SPECIAL WIRES FOR INCANDESCENT LAMPS

GERMAN SILVER WIRES FOR HIGH RESISTANCES, FLEXIBLE CORDS, TELEPHONE WIRES, &c., &c. MULTIPLE, AERIAL, AND SUBTERRANEAN CABLE WIRES TO ANY SPECIFICATION.

INDIA-RUBBER, GUTTA-PERCHA, & TELEGRAPH WORKS COMPANY, LIMITED.

Offices and Warehouses: 106 & 100, CANNON STREET, LONDON, E.C.
Works: Silvertown, Essex; Persan-Beaumont, France.

TELEGRAPH ENGINEERS AND MANUFACTURERS

OF

CABLES.—Submarine, Subterranean, and Aerial.

WIRE.—India-Rubber and Gutta-Percha covered in all gauges.

INSTRUMENTS.—"Morse" Inkers, Single Needle, Wheatstone's Alphabetical, Semaphore "Block" Instruments, Bells, Resistance Coils, Sir W. Thomson's, and other Galvanometers, Condensers, Testing Instruments, &c.

BATTERIES.—SOLE MANUFACTURERS FOR GREAT BRITAIN, IRELAND, AND THE COLONIES OF THE CELEBRATED LECLANCHÉ BATTERY, which has received the most favourable reports from the Postal Telegraph Authorities and other eminent Telegraph Engineers, and is now in general use by the Post Office and English and Continental Railways. As a Battery for all Telegraphic purposes it is undoubtedly pre-eminent. All other kinds of Batteries also manufactured. Ebonite Cells, Carbon Plates, &c.

INSULATORS.—Ebonite, Porcelain, Brownware, &c.

MANUFACTURERS OF THE MOST IMPROVED APPARATUS FOR RAILWAY BLOCK SIGNALLING.

SEMAPHORE REPEATERS, "LIGHT" INDICATORS, AND WALKER'S "PASSENGER AND GUARD" COMMUNICATOR.

TELEGRAPH STORES AND APPARATUS OF EVERY DESCRIPTION.

TORPEDO APPARATUS.

THE INDIA-RUBBER, GUTTA-PERCHA, AND TELEGRAPH WORKS COMPANY (Limited) are Patentees and Manufacturers of a Complete System of Torpedoes for Harbour and Coast Defence,

AND OF THE

SILVERTOWN PATENT FIRING BATTERY.

A Constant Battery for Mining and Blasting Purposes.

CONTRACTS ENTERED INTO for the SUPPLY, CONSTRUCTION, and MAINTENANCE of TELEGRAPH LINES.

MANUFACTURERS OF

VULCANISED INDIA RUBBER.

VALVES, SHEET, BUFFERS, SPRINGS, WASHERS, WHEEL TYRES, CORD TUBING, AND DOOR AND CARRIAGE MATS.

INDIA RUBBER AND CANVAS SUCTION AND DELIVERY HOSE.

INDIA RUBBER and CANVAS STEAM PACKING—ROUND, SQUARE, and SHEET.

INDIA RUBBER MACHINE DRIVING BANDS.

WATERPROOF GARMENTS AND FABRICS:

Coats, Capes, Leggings, Hats, Helmets, Knee Wrappers, Diving-Dresses, Sheeting for Hospitals, Water and Air Proof Beds, Pillows, Cushions, Bottles, Baths, Life Belts, Gas Bags.

EBONITE.

Not affected by Vinegar or Hydrochloric or Acetic Acid.

Pumps.
Photographic Articles.
Speaking Tubes, Mouthpieces.
Battery Cells.
Sheet and Rod.
Surgical Appliances.

GUTTA-PERCHA.

Tubing, Belting, Buckets, Bosses for Flax Spinning, &c.

WORKS: SILVERTOWN, ESSEX, LONDON, E.; PERSAN-BEAUMONT, FRANCE.
London Office—106, CANNON STREET, E.C.
Warehouse—100, CANNON STREET, E.C.

BRANCHES:

LIVERPOOL ... ... [illegible], Castle Street.
GLASGOW ... ... 30, Dixon Street.
BRADFORD, YORKSHIRE ... ... 35, Kirkgate.
SHEFFIELD ... ... 64a, High Street.
PORTSMOUTH ... ... 40, High Street.
BELFAST ... ... 33, High Street.
DUBLIN ... ... 15, St. Andrew Street.
BRISTOL ... ... 2, Clare Street.
NEWPORT, MON. ... ... 32, Dock Street.
CARDIFF ... Pierhead Chambers, Bute Docks.
NEWCASTLE-ON-TYNE ... 6, Neville Street.
NORTH SHIELDS ... ... Borough Road.
BIRMINGHAM ... ... Cobden Buildings, Corporation Street.